A Critical Analysis of an Instrument Used to Measure 21st Century Skills Attainment Among High School Career and Technical Education Students

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Educational Leadership

by

Dana Mast Ryan

Dr. George C. Hill/Dissertation Advisor

May, 2013
We recommend that the dissertation prepared under our supervision by

DANA MAST RYAN

entitled

A Critical Analysis Of An Instrument Used To Measure 21st Century Skills Attainment Among High School Career And Technical Education Students

be accepted in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

George C. Hill, Ph.D., Advisor

Bill Thornton, Ph.D., Committee Member

Janet Usinger, Ph.D., Committee Member

Mary Sedgwich, Ed.D., Committee Member

Michele Pelter, Ph.D., Graduate School Representative

Marsha H. Read, Ph. D., Dean, Graduate School

May, 2013
Abstract

“To prepare our children for the world of tomorrow, we must enhance the learning environments of today” (Partnership for 21st Century Skills, 2009, p. 24). In the first decade of the 21st Century, a common set of skills necessary for postsecondary success has emerged which includes creativity, critical thinking, problem solving, communication, and other applied skills. Acquisition of these skills is thought to give students the ability to continue learning and adjusting to change, effectively preparing them for postsecondary success in college, careers, and civic endeavors (ACTE, et al., 2009; Conley, 2007a; Kay, 2010; National Survey of Student Engagement, 2006). This new demand for 21st Century skills has challenged educational leaders to examine the context in which these skills are best taught, as well as the tools available to provide evidence that these skills are being learned in high school. To date, little research has emerged regarding measurement procedures for these non-academic skills.

The purpose of this study was to examine the reliability and validity of an instrument currently being used to measure student perceptions of 21st Century skill acquisition in a Career and Technical Education (CTE) high school. The research is a quantitative study to determine empirical factors of the survey instrument, as well as determine reliabilities. The study utilized existing data collected by the school during a routine annual program evaluation process. Factor analysis was used to analyze 396 student responses to 55 survey items to identify underlying constructs (factors). Five factors, reflective of 31 contributing survey items, emerged from the preponderance of evidence as most appropriate. To determine internal consistency, Cronbach’s alpha was conducted to analyze reliability among all items, among items related to each factor, and among factors. In all cases, the test for reliability ($\alpha > .70$) was met. In order to determine correlation among factors, Pearson’s correlation coefficient $r$ were computed. A significant
positive correlation was found among and between all five factors. Finally, a series of one-way multivariate analyses of variance (MANOVA) were used to determine whether differences existed among respondent demographic groups identified for gender, ethnicity, socio-economic status, high school zone of attendance, and program of study. When statistically significant differences occurred, an appropriate post hoc test was conducted. Results indicated no statistical difference in responses occurred in the demographic categories of ethnicity, gender, Socio-economic Status, or high school zone. Statistically significant differences were identified in the demographic category of Program of Study.

Two key finding emerged from this study. The first suggests that the instrument could be revised to reflect the five empirical factors associated with 21st Century skill acquisition, along with the 31 contributing survey items, resulting in a psychometrically sound tool. This would provide a shorter version of the assessment resulting in a reduction of time and resources necessary for administration. The second key finding of this study, based on the limited response differences among study groups, suggests that the instrument may yield similar results when implemented across a range of students from varying demographic backgrounds. Though follow up research should be conducted to provide data regarding the stability of the revised instrument over time, these findings may be helpful in advancing the search for an appropriate, efficient tool that would allow high school to assess acquisition of 21st Century skills.
Dedication

With great love and gratitude, I dedicate this work to my parents, Gifford and Judith Mast.

Thank you, Dad, for modeling goal setting, making and working a plan, and persevering through challenges. Mom, thank you for instilling in me the importance of beginning, middle, and end. I could not have finished this process without those lessons. In a broader sense, this work encompasses the values you taught me and that I hope have passed on to my own children: always give your best effort; embrace challenges as opportunities for creative solutioning; and barriers only exist when you allow them. You are my heroes. I love you.
Acknowledgements

It has taken a whole village to accomplish this monumental task. To the many people who have supported this journey, please accept my heartfelt appreciation.

I was truly fortunate to have the opportunity to work with Dr. Gus Hill, my committee chair. He helped me frame a study that honored my love for CTE and made a difference. He figured out my personality and adjusted his management style to motivate and encourage me, ensuring my success. In my darkest moments, he stayed calm and exercised great patience. He never let me give up. His foresight and guidance allowed me to finish this work.

Dr. Bill Thornton encouraged me to start this educational journey. He believed in my ability and potential long before I could see it for myself. During the process, he always had time for a word of encouragement (or a motivational lecture) and, on more than one occasion, dropped everything when I was on the verge of panic. I am thankful that he took the time to care about me.

Dr. Janet Usinger lent her talented mind to defining my study, narrowing the scope, and giving it boundaries. She helped me understand the relevance of the dissertation exercise and gave me insight into how others digest it. That perspective gave me an audience for whom to write. She was firm about her expectations while smiling and offering encouraging words. She inspired me and gave me permission to believe in my study.

Dr. Michele Pelter and Dr. Mary Sedgwick rounded out my team, asking thoughtful questions and provided quality feedback that helped create a better final product. I appreciate their commitment and enthusiasm for my topic.

Dr. Susan Kehoe was my cohort partner and as committed to finishing as I was. I am blessed to have her as a friend.
Many of my colleagues offered support and encouragement throughout the process. I am grateful to all of them. In particular, Rick Harris and Andy Kelly steered me toward this program and paved the way for my acceptance. My fabulous colleagues at the Academy of Arts, Careers & Technology monitored my progress, edited as necessary, and listened when I just needed to talk about the process. They took tasks, projects, and responsibilities off my plate so I could focus on writing. My first AACT principal (and friend), Janis McCreary gave priority to my studies and encouraged me to balance my time so that I could accomplish this goal. My second AACT principal, Bob Sullivan, embraced my mission to finish, gave me the freedom to visit my advisor frequently, and often tolerated unexpected tears as I neared the end. Sindie Read, administrative assistant extraordinaire, kept me organized and sane. She made sure I was where I needed to be every day – for work, family, and school. All of these tremendous people have championed me since the beginning and I hope I’ve made them proud!

Most of all, I am indebted to my family. They made this journey a success. My husband, Sean, tried to take on more at home so that I could focus on school. I didn’t know how let go. We struggled to find balance, stay connected, and grow together. I didn’t understand that he viewed the process as a team effort. Now I do. I am deeply touched by his unwavering commitment, support, and love.

Finally, my beautiful daughters, Kassi, Mya, and Gilli, sacrificed time with their mom so that I could achieve this big goal that they didn’t really understand. Neither Mya nor Gilli has ever known a time when I wasn’t going to school. I hope, as they move forward, they will value education and lifelong learning, as Sean and I do. And, as they look back on this time, I hope that they will believe their sacrifices were worth the outcome. I love you, girls. You are the heart of my heart.
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CHAPTER I

“To prepare our children for the world of tomorrow, we must enhance the learning environments of today” (Partnership for 21st Century Skills, 2009, p. 24). A decade ago, in an address to business leaders, Alan Greenspan noted the need to prepare high school students differently, suggesting a focus on conceptual skills that would allow them to learn and respond to innovation throughout their lives. This type of reform, he said, was critical because “the heyday when a high school or college education would serve a graduate for a lifetime is gone” (Greenspan, 2000, p. 1). True to his prediction, the first decade of the 21st Century showed an increased demand for workers with skills that were not reflected by current graduates: technical knowledge along with the ability to create, analyze, and transform information while interacting effectively with others (Greenspan, 2000; U.S. Department of Labor, Bureau of Labor Statistics, 2005). Today, business and educational leaders agree. To truly prepare high school graduates to adapt and succeed in a demanding, rapidly-evolving, postsecondary environment, high school education must change.

Ken Kay, president of the Partnership for 21st Century Skills (P21), has asserted that a specific skill set, in addition to mastery of traditional academic subjects, is necessary for postsecondary achievement in the new century. He, along with David T. Conley, Director of Standards for Success (a project of the Association of American Universities), has identified a common set of necessary skills for the 21st Century which include creativity, critical thinking, problem solving and other applied skills. Similar to Greenspan’s identification of the skills necessary for success in a new world, they found that competency in these skills “gives people the ability to keep learning and adjusting to

**Defining 21st Century Skills**

Twenty-first century skills are referenced and categorized in a variety of ways based on the audience and the application. In the early 1990s, they were broadly placed into three categories: basic literacy and computational skills; thinking skills necessary to put knowledge to work; and personal qualities that make workers dedicated and trustworthy (U.S. Department of Labor, 1992). These categories provided a solid foundation for the current set of skills identified as necessary for the 21st Century. The skills have been rearranged, redefined, and renamed. For example, the American Management Association (2010) referred to 21st Century skills necessary for management as the 4 Cs – critical thinking and problem solving; communication; collaboration; and creativity and innovation skills. The Partnership for 21st Century Skills (2009) categorized the skills needed for college and career readiness as a) learning and innovation skills; b) information, media, and technology skills; and c) life and career skills. The North Central Regional Educational Laboratory (2009) identified skills such
as digital-age literacy, inventive thinking, effective communication, and high productivity for success in postsecondary education and life. According to Kay (2010), these skills may be discussed using different nomenclature or categorized differently depending on the agency or application, but they are the same concepts. In all cases, he stated, these skills are “the ticket to economic upward mobility in the new economy” (as cited in Gewertz, 2007, p. 1).

For the purpose of this study, five broad areas of 21st Century skills were identified and examined based on the survey instrument being studied: a) job seeking and career development skills; b) communication skills; c) interpersonal skills; d) problem solving and reasoning skills; and e) business and economic skills (SkillsUSA, 2004). Because the 21st Century skills cannot be taught in isolation and are thought to be best used as a vehicle through which to learn academic skills, these categories are broadly defined and reflect overlapping skills, in many cases (P21, 2009). The five categories, as examined, are briefly described below.

- **Job Seeking and Career Development Skills**: The goal of this category is to acquire the skills necessary to identify, obtain, and keep a job. Developing a realistic career plan with associated goals, as well as learning specific skills such as resume development, interviewing, and application procedures, define this category (Conference Board, Partnership for 21st Century Skills, Corporate Voices for Working Families & Society for Human Resource Management, 2006; Hughes & Karp, 2004; SkillsUSA, 2006).

- **Communication Skills**: Thought to be at the heart of lifelong success, communication encompasses the use of language to create, express, and interpret
ideas through the four activities of reading, writing, listening, and speaking (Conley, 2007a; Carnevale & Desrochers, 2003).

- **Interpersonal Skills:** Self-confidence, honesty, openness, and the ability to work with others characterize this category (Robinson, 2000). These skills are also referenced as collaboration skills (AMA, 2010; Wagner, 2009), self-directional skills (P21, 2009), or teamwork skills (Conference Board of Canada, 2000).

- **Problem Solving and Reasoning Skills:** The ability to learn, to reason, to think creatively, to make decisions, and to solve problems defines this category (U.S. Department of Labor, 1990). Also called inventive thinking, habits of mind, and adaptability, these skills are thought to be the foundation for successful living across all roles of adult life (Merrifield, 2000; Gardner, 2007; NCREL, 2003; P21, 2009; Conley, 20010).

- **Business and Economic Skills:** Sometimes described as business or economic literacy, these skills are one of the major 21st Century themes that include understanding business processes and systems; the role of business in the U.S. and global economy; and how individual performance contributes to a company’s success (Carrier & Gunter, 2010; Conference Board, Partnership for 21st Century Skills, Corporate Voices for Working Families & Society for Human Resource Management, 2006; Partnership for 21st Century Skills, 2004).

**Career and Technical Education (CTE) in 21st Century Skill Development**

Career and Technical Education programs are emerging as a strong presence in the quest to provide opportunities to master 21st Century skills in high school. The Association for Career and Technical Education (ACTE) has asserted that many aspects
of CTE, through both program and pedagogy, already provide a working model for successfully teaching non-academic 21st Century skills (Association for Career and Technical Education, National Association of State Directors of Career Technical Education & Partnership for 21st Century Skills, 2010). Since 1998, when the Secretary’s Commission on Achieving Necessary Skills (SCANS) recommendations were included in CTE legislation and funding (H.R. 1853, 1998), soft skills (now referenced as 21st Century skills) have been integrated into the rigorous academic, employability, and technical curriculum offered in CTE courses (ACTE et al., 2010; U.S. Department of Labor, 1992). This, combined with evidence that CTE students experience lower dropout rates and higher achievement, strengthens the belief among CTE educators that their strength is in cultivating 21st Century skills in their students (ACTE, et. al, 2010; Kemple & Scott-Clayton, 2004; Wonacott, 2002).

**Problem Statement**

According to U.S. Secretary of Education, Arne Duncan, “To be on track today for college and careers, students need to show that they can analyze and solve complex problems, communicate clearly, synthesize information, apply knowledge, and generalize learning to other settings” (U.S. Department of Education, 2010). This changing demand for high school graduates who possess a specific set of 21st Century skills requires educational leaders to examine the tools that can provide evidence of the acquisition of these skills and the contexts where students can best learn them. To date, little research has emerged regarding how to best measure this type of non-academic skill attainment or the appropriate tools to be used to gather reliable data. Further, little research is available that suggests a connection between specific pathways or pedagogies that may contribute
to the attainment of a 21st Century skill set. Currently, a self-assessment instrument which purports to provide information about 21st Century skills acquisition is being used in various forms in many Career and Technical Education (CTE) programs and schools nationwide. Though widely used, this tool has no accompanying empirical evidence to support that it is measuring 21st Century skill acquisition.

**Purpose of the Study**

To address the gaps in research, this study examined the reliability and validity of an instrument currently being used with CTE high school students to measure 21st Century skill attainment. The instrument has been used in connection with CTE curriculum to gather information about the perceptions of high school students regarding their mastery of specific 21st Century skills (see definition on p. 13). The survey instrument used to gather student perception data was analyzed to determine empirical factors and determine the reliabilities. A secondary purpose of this research sought to explore relationships that existed among responses based on student membership in specific demographic groupings. The factor means identified in the initial analysis were compared to determine if differences in student perceptions were evident.

This research sought to expand the body of literature by providing empirical evidence related to CTE courses of study and 21st Century skills. As well, it sought to provide empirical evidence of differences or similarities in skill acquisition based on membership in specific demographic segments of the population or specific CTE disciplines. The information and insights provided could guide curriculum, assessment, and instructional strategies in future CTE programs.
Research Questions

In this study, school officials were reliant on a survey instrument, modified from a SkillsUSA self-assessment of 21st Century skill attainment, which had not undergone testing for construct validity. The study had a primary purpose of establishing the reliability and validity of the survey instrument as a tool to measure student perceptions of 21st Century skill acquisition. A secondary purpose was to explore the relationships that exist among student perceptions of mastery based on demographic group membership. Research questions guiding this study included:

Research Question 1. Given the sample of the study, what are the empirical factors for the survey instrument? To what extent are the empirical factors congruent with the original factors established by the developers of the instrument?

Research Question 2. Given the empirical factors established in question one, what are the reliabilities of the items that contribute to each factor?

Research Question 3. Do relationships exist among the various factors based on the responses from this study?

Research Question 4. For students who have completed a CTE course, are the perceptions of various groups, as defined by the demographic variables, different on factor subscales of the survey instrument? Of specific interest are groups established by Ethnicity, Gender, Socio-economic Status, High School Zone, and Program of Study.

Significance of the Study

This study provided significant information in several contexts. First, this study provided empirical information on the psychometrics of the assessment tool being used to evaluate student acquisition of 21st Century skills. The information obtained from the
results provided evidence that will likely allow school officials to make improvements to the existing instrument such that it will measure what they desire it to measure. As well, this study provided estimates of reliability on a limited sample which indicated that differences in perception may, in some cases, exist between males and female, as well as among students studying the CTE field of Education versus other disciplines. This suggested an avenue of further study. Finally, study results identified unreliable items included in the instrument that, if interpreted incorrectly, could lead to overconfidence or false reporting of the overall results.

In the context of career and technical education, the study may contribute to the very limited body of research on the ability of CTE pathways and courses to help students acquire 21st Century soft skills, providing empirical evidence where there has been none in the past. For the school and the district where this study was conducted, the results may allow for instrument modification to more accurately measure these skills. As well, it may serve as a guide for curricular conversations that will strengthen outcomes for CTE students, better preparing them for future success.

Finally, with regard to the current focus on how to best prepare students for postsecondary success in both college and career, these results could advance the dialogue regarding the potential role that CTE can play in the current reform movement. This may help stakeholders to identify replicable practices in CTE that, if applied in other disciplines, could increase 21st Century skill acquisition for more students. Additionally, these results could be utilized to guide CTE curriculum and strategy development to strengthen the connection between instruction and 21st Century skill acquisition, more closely meeting college and career readiness objectives in future CTE programs.
Limitations and Delimitations

This study was conducted recognizing the following limitations:

1. The data being used for the study had already been collected by the school and was not subject to any environmental or motivational controls by the researcher.

2. The data collected represented self-expressed opinions from the students using an arbitrary Likert-type scale.

3. The study was limited to one specialized school in a single district; therefore, limiting the ability to generalize the results to other schools or students.

4. The study did not meet the accepted minimum criteria for number of cases per variable (10:1). Though no recommendation for sample size is deemed appropriate for all studies, this may limit the ability to generalize the results to other schools or students.

5. The study did not attempt to determine prior exposure students may have had to the subject area of the CTE course in which they were enrolled.

6. Many variables outside the control of the researcher could impact the student growth and overall achievement. These variables may include: ancillary services provided by the district to students, the quality of instructional programs leading up to the current enrollment, the quality of instruction in the current enrollment, parental involvement in the students’ current and past education, honors and advanced placement program enrollment, and changes in the students’ circumstance during the school year.

The study has the following delimitations:

1. The researcher used all students with post-test results to determine outcomes.
Assumptions

This study included the following assumptions:

1. A college and career readiness construct exists.
2. Everyone who responded to the survey was honest.
3. Everyone who responded to the survey had been exposed to the vocabulary and concepts associated with the skill areas.
4. There would be no difference in response patterns by students based on part-time versus full time enrollment.

Definitions

The following definitions may have differing definitions when used in different contexts. Listed here are definitions used for the purposes of this study.

Advanced CTE course. A second or third level class taught in a 3 year CTE program of study sequence.

Career. An employment pathway that provides a family-sustaining wage, has established pathways to advancement, and requires postsecondary training or education.

Career and Technical Education (CTE). Educational classes that provide “coherent and rigorous content aligned with challenging academic standards and relevant technical knowledge and skills needed to prepare for further education and careers in current or emerging professions” (S. 250, 2006, p. 4). Courses are frequently offered in a sequence that is supplemented by internships or work based experiences at the more advanced levels (Association for Career and Technical Education, 2011).
**College and Career Ready.** Readiness to engage in postsecondary education and training, ranging from 2- and 4-year college programs to certificate and apprenticeship programs, without the need for remediation (Achieve, 2011).

**Construct.** Used to define a broad concept referring to an attribute a person can be assumed to possess (Sprinthall, 2007). In chapters 4 and 5, the term is used to refer to the 21st Century skills identified through factor analysis.

**Cronbach’s Alpha.** An index of reliability commonly used to measure the internal consistency or average correlation of items in a survey instrument (Santos, 1999).

**CTE.** Career and Technical Education.

**Factor.** Variations in independent variables that relate to and are components of a larger group of variables (Sprinthall, 2007).

**Factor Analysis.** A method of data reduction that analyzes relationships within a set of variables resulting in the construction of a lesser number of hypothetical factors which contain the essential information in the larger set of variables (Stapleton, 1997).

**Hard Skills.** These are basic skills and knowledge acquired through core academics typically taught in school. They are the cognitive skills that provide the foundation for applied skills (The Conference Board, Partnership for 21st Century Skills, Corporate voices for Working Families and Society for Human Resource Management, 2006).

**High School Zone.** An extension of the zoned high school, this is an administrative designation of the school district in which research was conducted that clusters district high schools into four arbitrary categories called zones.

**MANOVA.** Multivariate analysis of variance.
Multivariate Analysis of Variance (MANOVA). A statistical procedure designed
to test the significance of group differences when two are more dependent variables are
providing different measure of the same thing (Mertler & Vanatta, 2008).

Pearson’s correlation coefficient $r$. This is a measure of the relationship that
exists between two quantifiable variables when both variables represent interval
measures. The degree of relationship is represented by a correlation coefficient ranging
from -1.00 to 1.00 (Mertler & Vanatta, 2008).

Perkins IV. This refers to the Carl D. Perkins Career and Technical Education

Program of Study. A three or four year progression of coursework in a specific
career/technical field such as Agriculture, Business, Engineering, or Medical. For the
purpose of this study, the Program of Study designations used were defined by the school
where the research was conducted.

Reliability. The measure of an instruments consistency or repeatability
(American Education Research Association, American Psychological Association &

Respondents. For the purpose of this study, the term respondent is used to
describe the students who gave responses to the initial survey instrument upon which the
data set of scores was created. The research was limited to the data set, however, and the
researcher had no interaction with the respondents.

SCANS. Secretary’s Commission on Achieving Necessary Skills. This
commission was appointed in 1990 by the Secretary of Labor to determine what skills
young people needed to succeed in the world of work (U.S. Department of Labor, 1990).
**Soft Skills.** Often referred to as Applied Skills, these are skills that enable a person to apply knowledge they have acquired in school to successfully function in the workplace. Soft skills encompass cognitive skills, such as problem solving; social and behavioral skills, such as work ethic; and skills that combine both, such as collaboration and oral communication. Soft skills act as a complement to hard skills (The Conference Board, Partnership for 21st Century Skills, Corporate voices for Working Families and Society for Human Resource Management, 2006).

**SkillsUSA Professional Development Program (PDP) Self-Assessment Survey.** A survey developed in 1988 by SkillsUSA to help students identify the skills necessary to meet the demands of the postsecondary workplace. The survey was based on the findings of the U.S. Department of Labor’s Secretary’s Commission on Achieving Necessary Skills (SCANS) report (U.S. Department of Labor, 1990) and included 12 categories of hard and soft skills. The survey was developed as a self-assessment to be used in the PDP curriculum taught in high schools and colleges nationwide.

**21st Century Skills.** The skills and abilities deemed essential for a person to lead a successful life in the context of the demands of the 21st Century, such as the applied skills of critical thinking, problem solving, communication, and collaboration (North Central Regional Educational Laboratory, 2009; P21, 2011). For the purpose of this research, this term is used interchangeably with the term *soft skills.*

**Validity.** A measure of the “degree to which all of the accumulated evidence supports the intended interpretation of test scores for the intended purpose” (AERA et al., 1999, p. 11).
**Variable.** Measurable attributes of data that can vary. Variables are used in research to determine differences among outcomes (Sprinthall, 2007).

**Zoned high school.** An administrative designation that determines the high school each student should attend based on the area in which the student lives. This designation is assigned by the school district in which the research school is located.

**Zones.** An administrative designation assigned by the district in which the research was conducted that divides all schools within the district into areas referred to as zones.

**Summary and Organization of the Study**

A specific set of skills, in addition to traditional academic preparation, is necessary for success in the 21st Century. Acquiring these skills in high school will ensure that graduates are ready for college, career, and life. This study examined an instrument currently being used to measure 21st Century skill attainment in a career and technical education setting to determine reliability and validity. In the initial phase of the study, the instrument was analyzed to determine the empirical factors present in the survey and evaluated for congruence with the original factors established by the developers. Next, the identified factors were tested for reliability and examined for relationships among them. Finally, differences in response patterns based on demographic group membership were examined to determine if differences existed.

This research study is presented in five chapters. Chapter I summarizes the background of the study, a statement of the problem, the purpose of the study and the research problems, limitations and delimitations, assumptions, and a definition of terms. Chapter II contains a review of literature, including test instruments to measure 21st
Century skills, an overview of 21st Century skills, a discussion of reliability and validity, and the theoretical framework for factor analysis used for this study. Chapter III provides an overview of the methodology used for the research, including the structure, data acquisition procedures, and analysis techniques. Chapter IV documents the significant findings of the study and Chapter V delivers an analysis of study findings in relation to the theoretical framework and research questions, identifies potential contributions to the field of literature and research, and examines implications for career and technical education.
CHAPTER II

“Over the long term, the only way we’re going to raise wages, grow the economy, and improve American competitiveness is by investing in our people – especially their educations,” said Robert Reich (2010, p. 1), Chancellor’s Professor of Public Policy at the University of California, Berkley, and former Secretary of Labor for President Clinton. “Our young people – their capacities to think, understand, investigate, and innovate – are America’s future” (Reich, 2010, p. 1). Ken Kay, president of the Partnership for 21st Century Skills suggested this can only be accomplished through a new high school education model that “culminates in 21st Century skill readiness for college, careers and civic participation” (ACTE, et al., 2010, p. 4). According to Michael Dell, CEO of Dell, Inc., this means acquiring a new 21st Century set of knowledge and skills that will best position students to become leaders. “These 21st Century skills include the development of global awareness and the ability to collaborate and communicate and analyze and address problems. And they need to rely on critical thinking and problem solving to create innovative solutions to the issues facing our world” (Partnership for 21st Century Skills, 2009, p. 4).

The research and review of related literature that follows is organized into three main sections. The first section discusses existing instruments to measure student acquisition of 21st Century skills and, in particular, the instrument used for this study. The next section provides a review of the methods used for testing such instruments for reliability and validity. The final section defines 21st Century skills, briefly examining career and technical education as a context in which the skills are believed to be taught.
Test Instruments to Measure 21st Century Skills

In 2004, 67% of high school graduates enrolled in college (National Center for Education Statistics, 2005). Theoretically, they were prepared for a successful postsecondary educational experience. Of those, only 35% graduated in four years and only 56% earned a diploma after 6 years (Knapp, Kelly-Reid & Whitmore, 2006). This completion rate supports the findings of the Center for Educational Policy Research that a gap exists between high school and college expectations in both academic performance and soft skills (Conley, 2003). Following a comprehensive study that included postsecondary institutions, high performance workplace managers, and K-12 educators, the American Diploma Project concluded that to be successful in a postsecondary environment, “a high school graduate must be able to blend knowledge and skills from many areas to identify, formulate and solve problems; to connect new information to existing knowledge; and to access and assess knowledge from a variety of sources delivered through a variety of media” (American Diploma Project, 2004, p. 24).

Given the skills required to be successful in a 21st Century postsecondary context, this has logically led to a call for assessments that accurately measure these non-cognitive readiness factors independent of academic ability (P21, 2009). This type of assessment has been slow to develop for large-scale implementation due to the indirect and contextualized nature of the skills being measured, limited knowledge regarding how to assess the skills, and limited availability of tools proven reliable (Scardamalia, Bransford, Kozman & Quellmalz, 2012). Currently, there are a variety of tools available that offer a promising avenue to measure 21st Century skills attainment in high school students (P21, 2009). However, these instruments are not widely available, are often difficult to
administer on a large-scale, and are not psychometrically proven measurements (Scardamalia, et. al., 2012). As well, repeated searches of literature databases yielded little or no evidence of research-based self-assessment tools that would indicate that the assessments being used are measuring what stakeholders believe they are measuring. This review of literature begins with an examination of those large-scale instruments available, as well as the self-assessment instrument that is the subject of the research.

**Existing instruments.** Most commonly used assessments measure student knowledge of discrete academic facts rather than those commonly associated with 21st Century skills, such as the application of knowledge in complex, challenging, and rapidly changing situations. In most cases, these tests “do not generate evidence of skill sets that the business and education communities believe will ensure success in the 21st Century” (P21, 2009, p. 2). Though no assessments of 21st Century skills attainment are in widespread use today (Scardamalia, et al., 2012), several models have emerged that may provide a foundation for a generally accepted measure.

The Information, Communication and Technology (ICT) Literacy Assessment, developed by Educational Testing Service, is designed to measure the ability to think critically to solve realistic problems using digital technology and communication tools. The assessment is most commonly used for students transitioning from high school to college (ETS, 2004). The Council for Aid to Education has developed the internet-based College and Work Readiness Assessment (CWRA) specifically for use in high schools with a focus on critical thinking, problem solving, analytical reasoning, and writing skills (Hersh, 2008). Other assessments include PowerSource, a project of the National Center for Research on Evaluation, Standards, and Student Testing (CRESST) at the University
of California, Los Angeles (UCLA) (Phelan, Vendlinski, Choi, Dai, Herman & Baker, 2011); the National Career Readiness Certification and WorkKeys, offered through the workforce preparation branch of ACT, Inc. (ACT, 2011); and tools developed by the Partnership for Assessment of Readiness for College and Careers (PARCC) which are estimated to be ready for field testing in the 2012-13 school year (Partnership for Assessment of Readiness for College and Careers [PARCC], 2011). As well, many schools and organizations across the nation are implementing promising assessment practices with regard to measuring and documenting student acquisition of 21st Century skills attainment (P21, 2009). To date, however, these practices have neither been researched for reliability or standardized for widespread implementation.

The paucity of research-based measures for postsecondary readiness that are both reliable and resource-friendly represents a challenge for educators who need tools for use with current students. To compensate for this, many schools are augmenting traditional academic measures with student self-assessment data to help gauge postsecondary readiness in areas of contextual skills, strategies, applied problem solving, and behavioral skills (Conley, 2007b, 2010; Lai & Viering, 2012). The use of self-assessment data is supported by research that suggests that the development of college readiness skills is facilitated by student awareness and planning around key areas such as cognitive strategies, content knowledge, contextual skills and awareness, and academic behaviors (Conley, 2007b, 2010). However, repeated searches of literature databases yielded little or no empirical evidence of tools that would indicate that the assessments being used are measuring what stakeholders believe they are measuring.
Development of current survey instrument. SkillsUSA, a national organization that works with high school and college students to prepare them for careers in trade, technical and skilled service occupations, provides a self-assessment activity as part of the student Professional Development Program (PDP) curriculum (SkillsUSA, n.d.). This program, which guides students through 76 employability skill activities, is taught by CTE teachers nationwide as part of a comprehensive curriculum that links academics, occupational programs, and communities together to prepare students for success in professional environments. The self-assessment tool included in the curriculum allows students to annually track their progress throughout high school and college in the areas of academic achievement, 21st Century skills attainment, and workplace readiness ability. It has been modified three times since implementation in 1988 (M. Davies, personal communication, September 15, 2011).

Based on findings of the U.S Department of Labor’s SCANS report, the instrument is divided into 12 categories of skills deemed necessary to meet the demands of the workplace (SkillsUSA, n.d.; SkillsUSA, 2004). These 12 categories include academic skills, such as math, reading, and writing, as they apply in the workplace. They also include skills related to obtaining and maintaining a job such as career development skills, work activity skills, economic skills, and thinking skills (U.S. Department of Labor, 1990). Within each category, specific related tasks are presented for which students can rate their perceived competency on a scale of one to three in a paper/pencil format (SkillsUSA, 2004). Although this is a widely-used instrument, no empirical data about the instrument has been available (M. Davies, personal communication, Sept. 15, 2011).
The data used for this research were obtained from a survey instrument developed by school personnel from the SkillsUSA self-assessment tool with the intent to gather specific information about 21st Century skills attainment. The survey reflected only 5 of the twelve categories included in the original PDP self-assessment. These five categories were thought to represent the skills needed to obtain and maintain a job, such as communication, problem solving and reasoning, and business and economic knowledge. Under the umbrella of these five categories, 55 questions assessed individual tasks on a scale of one to five, where one represented ‘I have not been taught this yet’ and five represented ‘I am really good at this.’ The instrument, given in an electronic, internet-based environment, also included nine questions related to learning style and student achievement (which were not included in this study). Reliability and validity was not available, as discussed in the statement of the problem.

**Twenty-First Century Skills**

“The term 21st Century skills is not a vague and squishy catchword that can mean anything,” said Kay (2010, p. xvi). Rather, these skills have been defined and categorized by numerous organizations, all relying on the framework provided by the 1990s report from the U.S. Department of Labor Secretary’s Commission on Achieving Necessary Skills (SCANS). At that time, the SCANS was tasked with determining what needed to be taught in schools in order to prepare students for the demands of the work world. The commission identified a three part foundation necessary for student workplace success: basic literacy and computational skills; thinking skills necessary to put knowledge to work; and personal qualities that make workers dedicated and trustworthy (U.S. Department of Labor, 1992). Basic literacy and computational skills
encompass traditional academic knowledge, falling under the heading of measurable or “hard” skills. Thinking skills and personal qualities, though more difficult to measure, were identified as the complementary “soft” skills that allow students to adapt to change, assume personal responsibility, and prepare them for life. The second set of skills, also described as non-cognitive behaviors, are known as 21st Century skills and recognized as necessary for postsecondary success.

The commission defined two categories of skills necessary for success in a high-performance workplace, foundations and competencies (as shown in Figure 1). They defined competencies as “the skills necessary for success in the workplace” and foundations as “those skills and qualities that underlie the competencies” (U.S. Department of Labor, 1992, p. 17). The commission described the foundations and competencies as generic (required for most jobs) and indicated that the competencies could not be achieved without the foundation, though the two should be learned concurrently (U.S. Department of Labor, 1992; 1999).
Since SCANS provided an initial definition for 21st Century skills in the early 1990s, the national conversation around college and career ready graduates has
intensified. Employers and post-secondary faculty have agreed that high school graduates lack a comprehensive set of 21st Century skills which is a contributing factor to low postsecondary graduation and job-retention rates (Carnevale, 2008; Conley, 2007a; Knapp, Kelly-Reid, & Whitmore, 2006; Olson, 2007). Many organizations, in response to the increasing demand for graduates with 21st Century skills, have responded by developing categories and standards to define necessary skills. There are many perspectives and voices in the on-going dialogue around 21st Century skills. For the purpose of this research, five skill categories have been identified for study based on the instrument being tested. Those categories, which will be examined in detail, are: (1) Job Seeking and Career Development Skills; (2) Communication Skills; (3) Interpersonal Skills; (4) Problem Solving and Reasoning Skills; (5) Business and Economic Skills. Finally, Career and Technical Education (CTE), which has been identified as an educational context that successfully teaches 21st Century skills through an integrated curriculum of academic and technical skills, will be discussed briefly to provide a framework of understanding for the school in which the research was conducted.

**Job seeking and career development skills.** “Today a majority of high school students spend little time and effort exploring and evaluating what they want to do when they enter their work lives. As a result, they have little understanding of the workplace, and no action plan to prepare for a happy and successful future” (Bendt, 2008, p. 1). Giving young people the tools to develop a realistic plan for their futures, such as developing a career plan and occupational goals, identifying potential employment positions, and learning the skills to successfully get and keep a job, is a primary goal of education (Hughes & Karp, 2004; SkillsUSA, 2006).
Job seeking skills, sometimes called employability skills, are considered to be foundational. They are the basic skills necessary for getting, keeping, and doing well on a job (Robinson, 2000). The skills include finding information about potential jobs, preparing necessary documents (resumes, portfolios, applications), interviewing for jobs, and good work habits and ethics (Pucillo, 2011). Career development, defined by the Carl D. Perkins CTE Improvement Act of 2006, provides access to information for career awareness and planning with respect to occupational and academic future (Threeton, 2007).

The importance of both job seeking skills and career development can be traced back to the early 1900s when Frank Parsons, credited as the father of career guidance, developed a scientific procedure for helping people chose a vocation as a way to improve the efficiency of both factories and individuals (Parsons, 1909). A commitment to career development and associated job seeking skills has continued to play an important role in federal educational policy, evidenced by the inclusion of goals for career development in such legislation as the 1917 Smith Hughes Vocational Education Act of 1917, the Vocational Education Act of 1963, the Educational Amendments of 1974, the School-to-Work Act of 1994, and the Carl D. Perkins legislation, most recently the Carl D. Perkins CTE Improvement Act of 2006 (Perkins IV) (Threeton, 2007).

**Basic skills for a technical world.** According to employers, “the future U.S. workforce is here – and it is woefully ill-prepared for the demands of today’s (and tomorrow’s) workplace” (Conference Board, Partnership for 21st Century Skills, Corporate Voices for Working Families & Society for Human Resource Management, 2006, p. 9). While many other 21st Century skills have a close connection to increased
use of technology, job seeking skills such as strong face-to-face interview skills, knowledge of the job application process, and proper dress are emphasized in this category. As well, career development skills include an overall understanding of occupational characteristics and the corporate big picture (Carrier & Gunter, 2010). According to Halligan, Vice President for Human Resources at Great River Health Systems, “Every employee needs to understand how they fit into the strategic plan; it takes all 1,700 employees to reach our goals, and each employee needs to understand how their job impacts those goals” (Conference Board, et al., 2006, p. 25).

Strong partnerships between business and education, such as work-based learning programs, enable students to learn these skills, as well as connect academic learning to future workplace success. Industry partnerships “help students become personally aware of the standards that employers expect and lead them to reflect on the in-school learning that complements the achievement of those standards” (Lankard, 2003, p. 2). Students who practice job seeking and career development skills through their extracurricular activities, work-based learning opportunities, or part-time jobs greatly enhance their credentials and get a head start at building advantages that are important to employers. As well, they increase their chances of earning admission to college (Bendt, 2008).

**Career development for college and career readiness.** According to Bendt (2008), author of the book, *A Roadmap to Career Success: 25 Tips for College-Bound Students*, “Students who explore occupations are more likely to pursue a career path they find interesting and fulfilling” (p. 1). Unfortunately, the majority of high school students today spend inadequate time exploring and evaluating what they want to do when they enter their work lives; thus, enter college with little direction or understanding of how the
real world functions (Bendt, 2008). This lack of planning and consequent indecision increases the possibility of additional years of postsecondary education which becomes a substantial financial penalty (Bendt, 2008). As well, the lack of focus on career development in high school translates into graduates who lack the skills to be successful in the workplace and college (Conference Board, Partnership for 21st Century Skills, Corporate Voices for Working Families & Society for Human Resource Management, 2006). Effective job seeking and career planning programs integrated with opportunities to practice these skills in real world setting, prepare students to achieve success in all aspects of postsecondary life (Bendt, 2008).

**Communication skills.** “Both researchers and the business community agree: effective communication skills are essential for success in today’s knowledge-based society” (NCREL, 2003, p. 31). This sentiment is echoed by Carnevale and Desrochers (2003), who described the importance of communication skills to the smooth operation of all businesses as secondary only to “knowing how to learn” (p. 41). Similarly, Conley (2007c) cited communication in the context of academic behaviors as a critical skill leading to success in the postsecondary educational environment (Conley, 2007c).

At a basic level, communication skills were defined as reading, writing, listening, and speaking (U.S. Department of Labor, 1992). In a complex form, they are defined in such terms as “use relevant scientific, technological and mathematical knowledge to explain or clarify ideas” (Conference Board of Canada, 2000, p. 2) and “understanding, managing and creating effective oral, written and multimedia communication in a variety of forms and contexts” (P21, 2004, p. 9). In practical terms, these skills include the ability to effectively communicate with peers and colleagues, interact with people from
diverse backgrounds, and communicate clearly both formally and informally (Conley, 2007c). Though terms may vary from organization to organization based on purpose and audience, behaviors and skills associated with effective communication are foundational skills necessary for college and career success (Conley, 2007a; Carnevale & Desrochers, 2003).

**Identifying and measuring specific communication skills.** Communication is rooted in the basic academic skills of reading and writing competency, which are easily defined and measured through multiple standards-based assessments at all educational levels (U.S. Department of Labor, 1992). Less easily defined and measured are the skills and abilities associated with listening and speaking. They are broad concepts that are difficult to measure in isolation from one another and often need to be broken into smaller, more readily attainable tasks in order for the skills to be taught, measured and acquired. The SCANS report defines listening and speaking in the following ways:

*Listening:* Receives, attends to, interprets, and responds to verbal messages and other cues such as body language, in ways that are appropriate to the purpose – for example, to comprehend, learn, critically evaluate, appreciate, or support the speaker.

*Speaking:* Organizes ideas and communicates oral messages appropriate to listeners and situations; participates in conversation, discussion, and group presentations; selects an appropriate medium for conveying a message; uses verbal language and other cues such as body language in a way appropriate in style, tone, and level of complexity to the audience and the occasion; speaks
clearly and communicates a message; understands and responds to listener feedback; and asks questions when needed. (SCANS, 1992, p. 99).

In the 2009 Readiness Profile developed by Equipped for the Future, a research project of the National Institute for Literacy, the skills associated with communication were categorized as 1) speak so that others can understand, 2) listen actively, 3) read with understanding, and 4) observe critically. Conference Board of Canada (2000), in the Employability Skills 2000+ document, translated the SCANS definitions into some specific actions and behaviors needed to enter, stay in, and progress in the world of work. These include such things as:

- listen and ask questions to understand and appreciate the points of view of others
- write and speak so that others pay attention and understand
- use relevant scientific, technological and mathematical knowledge to explain or clarify ideas (Conference Board of Canada, 2000, p. 2)

*Communication skills for a technical world.* In recent years, the ability to communicate using the rapid advances in technology have been included in the various definitions that encompass necessary communication skills. For example, the West Virginia Department of Education (2008) combined information and communication skills, stating, “information processing skills include information and media literacy, visual literacy as well as communications and technology literacy, and oral, written and multi-media communication” (p. 1). The Partnership for 21st Century Skills (2004) combines information and communication under the heading of cognitive learning skills. Beneath this heading are the categories of Information and Media Literacy Skills
(analyzing, accessing, managing, integrating, evaluating and creating information in a variety of forms and media) and Communication Skills (understanding, managing and creating effective oral, written and multimedia communication in a variety of forms and contexts) (P21, 2004, p. 9). The enGauge 21st Century Skills document defined the skills students need to thrive in the digital age. In the category of effective communication, questions such as “Do students generate meaning through exchanges using a range of contemporary tools, transmissions, and processes?” (North Central Regional Educational Laboratory, 2003, p. 3) are posed. The focus of these definitions demonstrates the evolving skills required to manage communication in today’s digital context.

*Communication for college and career readiness.* Communication for college readiness can be defined as the “ability to interact successfully with a wide range of faculty, staff and students, including those who come from different backgrounds and hold points of view that differ from those of the student,” (Conley, 2007c, p. 18). Students entering college with deficiencies in communication skills, such as the ability to communicate both academically and informally, have lower completion rates. Conley posited that this can be attributed, in part, to a reduced sense of accomplishment based on lower grade attainment which detracts from a positive college experience.

Similarly, employers have identified the ability to communicate, defined as synthesizing and transmitting ideas in written and oral formats, as an essential and highly valued skill. In a 2010 survey conducted by the American Management Association (AMA) in cooperation with the Partnership for 21st Century Learning, employers from a broad cross-section of the marketplace indicated that the ability to communicate was measured on annual performance reviews and was a priority for employee development.
The majority of respondents reported their companies already make an effort to assess communication skills of potential employees and identified a significant lack of communication skill level in their employees who were recent graduates compared to their more experienced colleagues. Both employers and postsecondary faculty agreed that integrating academic instruction with opportunities to learn and apply the 21st Century communication skills desired in college and the workplace would help ensure that students leave high school prepared for success (AMA, 2010; Conley, 2007a).

**Interpersonal skills.** “The business community needs capable, enterprising employees in order to compete in a global economy...employees who are capable of working together across the globe to solve complex problems,” wrote Cheryl Carrier, Education Program Director for Ford Motor Company (National Career Pathways Network & Institute for a Competitive Workforce, 2009, p. 2). Similarly, Conley stated, “the likelihood for success in college is higher among students who possess interpersonal and social skills that enable them to interact with a diverse cross-section of academicians and peers” (2007a, p. 17). These skills are also described as collaboration skills, personal qualities, teamwork skills, and self-directional; they are considered the skills required for leadership, negotiation, and management (Conley, 2007a). While these skills often overlap with communication skills, interpersonal skills have emerged as a critical category of their own.

The 1991 SCANS report, *What Work Requires of Schools*, generally defined interpersonal skills as the ability to work with others. Specifically, this category includes such abilities as accountability, self-confidence, empathy, positive attitude, cooperation, and metacognition (Robinson, 2000; Conley, 2007a). Attitude, which encompasses such
things as self-direction, empathy, and ethics, has also come to the forefront in recent years as a critical component of interpersonal skill development (Iowa Department of Education, 2009). In a world characterized by constant change, mastering interpersonal skills gives students a strong advantage in adjusting to ever changing circumstances, providing them with both the flexibility and security to act, respond, and learn from each situation (P21, 2004).

**Interpersonal skills for group effectiveness.** Carnevale and Desrochers (2003) described interpersonal skills as a function of group effectiveness, a common productivity strategy used in most business and academic settings. This includes such skills as teamwork, negotiation, influence, personal management, and attitude (Carnevale & Desrochers, 2003; Conley, 2007a). Conference Board of Canada (2000) recognized teamwork as a critical interpersonal skill needed for success in all areas of life, defining it as “the skills and attributes needed to contribute productively” (p. 2). In the definition, the Board included working with others and participating in projects, as well as requiring individuals to negotiate multiple perspectives and unique personalities while directing a wide range of skills through a group effort in order to accomplish a singular task (Carnevale & Desrochers, 2003). To demonstrate these abilities requires the ability to accept constructive criticism, be intellectually open to new ideas, and a willingness to change personal views, if necessary (Conley, 2007a). A key component of the teamwork process is the ability to exert influence. Influence, related closely to organizational effectiveness and leadership, plays an important role because “every person may need, at times, to influence a work group or provide a vision of what the organization as a whole requires” (Carnevale & Desrochers, 2003, p.43). The ability to work on a team is
important for success in both the workplace and postsecondary education (Carnevale & Desrocher, 2003; Conference Board of Canada, 2000; National Survey of Student Engagement, 2006).

The ability to negotiate personalities and assert influence is directly linked to the skill of personal management, defined as possessing healthy self-esteem, motivation, goal-setting ability and metacognition (Carnevale & Desrocher, 2003). People with healthy self-esteem can recognize their own skills and limits, have an awareness of their impact on others, and understand how to cope with stress, change, and criticism (Conley, 2007a). This awareness, related to metacognition (the ability to think about how one is thinking), manifests in such behaviors as reflection on what worked and what did not; persistence through ambiguity or challenge; systematic application of strategies; and the transference of learning from one context to another (Conley, 2007a). Coupled with healthy motivation, the skills related to group effectiveness yield high on-the-job and academic performance through goal setting.

**Attitude.** The Partnership for 21st Century Skills cited the increased demand for global competitiveness as the justification for including attitude traits within this category (P21, 2004). In order to compete with high income, high growth countries using the most advanced methods to produce innovative products and services (Porter, Ketels & Delgado, 2007, as cited in P21, 2008c, p. 7), the United States must have a nimble workforce characterized by an attitude of creativity, innovation, and adaptability. In order to create cross-border solutions, they stated, that workforce must also exhibit mastery of skills including “greater sensitivity to cultural differences, openness to new and different ideas, and the ability to adapt and change” (P21, 2004, p. 7).
Interpersonal skills for college and career success. Workers and students with good interpersonal skills view themselves as part of the team, have a positive attitude that contributes to the culture of the group, and take the initiative to learn new things (Conley, 2007a). These skills are critical to the mastery of new rules and expectations in postsecondary venues that may not be explicitly taught but must be rapidly understood through context, inference, and trial and error (Conley, 2007a). Conley (2007) pointed out that college is often the first setting where young people are expected to act and function as adults. Strong interpersonal skills, such as confidence, self-direction and a positive attitude, help them overcome challenges and adapt to a new environment (Conley, 2007a).

In the Workplace Fact Sheet for the Alabama Cooperative Extension, Robinson (2000) defined interpersonal skills as “the skills, attitudes and actions that enable workers to get along with their fellow workers and supervisors and to make sound, critical decisions” (p. 1). The accompanying list included such characteristics as self-confidence and self-control; honesty and integrity; responsibility; team spirit; good attitude; self-motivation, self-direction and cooperation; and adaptability. “Entry-level employees with good personal skills have confidence in themselves and deal with others honestly and openly, displaying respect for themselves, their co-workers, and their supervisors regardless of other people’s diversity and individual differences,” Robinson stated (2000, p. 2). Conley (2007a) and Robinson (2000) agree that failure to teach young people these critical skills, including personal responsibility and accountability, is the equivalent of placing education and employability barriers in their path.
Interpersonal skills for a technical world. The North Central Regional Educational Laboratory (NCREL, 2009), which placed interpersonal skills, teaming and collaboration, and personal responsibility under the broad heading of effective communication, articulated an expectation that students must have the skills to be prepared for success in a digital era. They pose such questions as “Do students demonstrate a depth and currency of knowledge about legal and ethical issues related to technology, combined with an ability to apply this knowledge to achieve balance, integrity, and quality of life as citizens, family and community members, learners, and workers?” (NCREL, 2009, p. 3). NCREL added an additional characterization of interpersonal skills called inventive thinking. As part of inventive thinking, essential guiding questions highlight traits such as adaptability, self-direction, curiosity, and risk taking, while applying them in their most modern context as a reflection of the rapidly changing technologies and demands of the 21st Century (NCREL, 2009).

Interpersonal skills are critical 21st Century skills. They include the ability to collaborate and work as a team, accept and work with people from diverse backgrounds, understand the cultural norms and protocols for interacting in specific environments, and demonstrate leadership skills in a variety of settings (National Career Pathways Network & Institute for a Competitive Workforce, 2009; Carnevale & Desrochers, 2003; Conley, 2007). They extend to the digital world through complex skills, such as visual, technological, media, and contextual literacy (NCTEF & SCCI, 2008; West Virginia Department of Education, 2008; P21, 2004). They are the central skills through which mastery enables the smooth navigation of the postsecondary venues of business, education, family and community.
Problem solving and reasoning skills. “A person who can think critically, act logically, and evaluate situations to make decisions and solve problems, is a valuable asset” (Robinson, 2000, p. 2). Those with skills to problem solve and reason in changing contexts, particularly when combined with high levels of communication and interpersonal skills, are well positioned to succeed in highly productive, innovative postsecondary environments (Carnevale & Desrochers, 2003). Employers and college faculty across the country cite critical thinking and problem solving skills, along with adaptability, among the most important skills needed by high school graduates. Both groups identify deficiencies in this area as a primary concern (Carnevale & Desrochers, 2003; Lundell, Higbee, Hipp & Copeland, 2004).

People who have learned how to learn can efficiently and competently manage and respond in an era of rapid changing technology and processes (Carnevale & Desrochers, 2003; Carnevale, 2006). As rapid technological advances have made simple tasks easier, a greater dependence on higher level thinking skills has necessarily emerged to manage complex tasks. “Critical thinking empowers Americans to assess the credibility, accuracy and value of information, analyze and evaluate information, make reasoned decisions and take purposeful action” (P21, 2008, p. 10). The ability to apply reasoning and problem solving skills increases an individual’s ability to manage daily life and increases potential value as an employee (NCREL, 2009; Cradler, 1994 as cited in P21, 2004, p. 10).

Adaptability. Adaptability describes the application of problem solving and reasoning, in context, to respond to the demands of specific situations in order to recognize and define problems, invent and implement solutions, and track and evaluate
results (Carnevale & Desrochers, 2003). These skills are at a high premium in both the workplace and the postsecondary educational environment because of increased pressure to improve productivity and competitiveness. However, these skills cannot be isolated from other 21st Century skill sets. When combined with high level cognitive skills, group interaction skills, and problem-processing skills, the result is an atmosphere ripe for high levels of creative problem solving. This highly productive setting is characterized by effective teamwork, new approaches to problems, and the invention of new solutions (Carnevale & Desrochers, 2003).

**Thinking skills for a technical world.** “Because technology makes the simple tasks easier, it places a greater burden on higher level skills” (International Information and Communication Technology Literacy Panel (ICT), 2002, p. 6). Technology is a driving force in the workplace, communities, and personal lives, and will continue to play a prominent role in the future (P21, 2004). In the current digital age, the ability to adapt and master new technology, utilize it as a problem solving tool, and creatively apply reasoning and problem solving skills using technology promotes mastery of workforce skills and increases an employees’ value in the workplace (NCREL, 2009; P21, 2004).

The North Central Regional Educational Laboratory (NCREL) referred to the need for higher-order thinking and sound reasoning, stating that “as technology becomes more prevalent in our everyday lives, cognitive skills become increasingly critical” (NCREL, 2009, p. 2). This is reflected in the essential question under the heading of problem solving and reasoning, “Are students adept at cognitive processes of analysis, comparison, inference/interpretation, evaluation and synthesis, as applied to a range of academic domains and problem-solving contexts?” (NCREL, 2009, p. 2). Because it is
impossible to predict what tools will be essential for learning and working in the future, skills such as self-direction, curiosity, and adaptability will be needed to respond to the continuing evolution of available technology. As the mix and range of media changes, “it is important for people to acquire the learning skills that will enable them to learn to use the next generation of technology” (P21, 2004, p. 10).

**Reasoning skills for college and career success.** The Knowledge and Skills for University Success (KSUS) study, developed by the Association of American Universities and the Pew Charitable Trust, found habits of mind that students develop in high school to be one of the most dominant concerns identified by the faculty and staff of the research universities (Conley, 2003). David Conley, in his opening letter for the KSUS report, stated that these habits, which include critical thinking, analytical thinking, problem solving, an inquisitive nature, and an openness to possible failure, were considered by university faculty to be more important than content knowledge. Said one faculty member, “Students need to have a curiosity about the questions we raise in the class, and a desire to want to explore the complexity of the social and moral issues we address. Then you can give them the tools. If they are disengaged from education, then it is a lot harder” (Conley, 2003, p. 55).

Similarly, employers across the country identify critical thinking and problem solving as a fundamental skill for employability (Conference Board et al., 2006; Cotton, 1993). These skills include identifying problems and their root causes, evaluating information, implementing creative solutions, and applying knowledge in such a way as to think, gain, and share knowledge (Conference Board et al., 2006). Workers who have learned how to learn become competent and efficient at acquiring new skills, as well as
mastering technological advances and altered work processes. This, in turn, helps employers meet the strategic goals and competitive challenges of business survival (Carnevale & Desrochers, 2003; Carnevale, 2006).

Problem solving and reasoning skills provide people with both flexibility and security as they navigate a world that is increasingly sophisticated, multifaceted, and nuanced (P21, 2004). These skills transfer to all the roles of adult life and are applied continuously throughout the course of living (Gardner, 2007). Personally and professionally, individuals are challenged to make intelligent consumer choices, raise children, participate in sophisticated economic activities, and evaluate media perspectives. These tasks require them to connect new information to existing knowledge, access and apply information to solve problems, adjust to changing circumstances, and act constructively to make decisions (P21, 2004).

**Business and economic skills.** “Most people enter the workplace after high school or college without even a rudimentary understanding of the business processes, entrepreneurial spirit or economic forces that shape their lives” (P21, 2004, p. 13). To best prepare students for making the sophisticated economic and business choices that can profoundly affect their future, understanding such things as workplace organization, systems of operation, and how individual performance can contribute to a company’s success are critical (Carrier & Gunter, 2010).

These skills, sometimes referenced as business and economic literacy, represent essential knowledge for success in the 21st Century global community (P21, 2004). In a 2006 survey, employers classified these skills under the heading of personal responsibility, defined as exercising personal financial responsibility and using
entrepreneurial skills, and over 70% of the respondents found them to be one of the top 3 emerging content areas considered most critical for future graduates (Conference Board, Partnership for 21st Century Skills, Corporate Voices for Working Families & Society for Human Resource Management, 2006). These were followed in order of importance by the ability to “understand economic issues and the role of business in the U.S. and global economy” and “demonstrate understanding of global markets and the economic and cultural effects of globalization” (Conference Board et al., 2006, p. 52).

**Economic literacy for a digital world.** The International ICT Literacy Panel (2002) updated and expanded the traditional dictionary definition of literacy from the ability to read and write to the ability to use digital technology, communications tools, and/or networks to function in a knowledge society. Using this definition as a guide, the enGauge 21st Century Skills document places economic skills, such as identifying economic issues, analyzing incentives, and examining the consequences of changes in economic conditions and public policies, under the heading of digital-age literacies (North Central Regional Educational Laboratory, 2003). When cross-matched with the competencies identified by the 1991 SCANS report, this reflects a more explicit interpretation of both the information and systems competencies (U.S. Department of Labor, 1991).

**Business and economic skills for college and career success.** In 2006, the Association of Career and Technical Education (ACTE) advocated for the goal of preparing every student for full participation in college, meaningful work, career advancement and active citizenship. To that end, they recommended that this include learning about the economy, as well as developing a “knowledge and understanding of
local, state, and national educational, occupational, and labor market opportunities, needs, and trends” (ACTE, 2006, p. 1). Diane Barrett, Vice President, National Education Program and Sales Services for USA TODAY, argued that knowledge of business and economics has a direct link to leadership, a skill identified in the P21 framework as essential for life and career (P21, 2008). “College graduates’ lack of understanding of corporate policies and procedures inhibits their effectiveness in performance reviews. They don’t know what questions to ask in performance reviews or how to use the feedback received” (Conference Board et al., 2006, p. 39) which serves as a barrier to the development of leadership skills.

While students should begin acquiring these skills in high school, it is important that they continue to hone their business and economic skills throughout college so that they are familiar with the business world when they arrive in the workplace (Conference Board et al., 2006). These skills provide students with a foundation for success in a rapidly changing world in which it is hard to imagine what specific types of technical skills will be required in the future. According to Cheryl Carrier, 21st Century Education Program Director for the Ford Motor Company, the more important demand will be for enthusiastic employees who recognize that business acumen “is part of every career and job they will compete for in the future” (National Career Pathways Network & Institute for a Competitive Workforce, 2009, p. 2).

**Career and technical education.** In recent years, career and technical education (CTE) has gained recognition as a reliable pathway that successfully fosters 21st Century skills development (ACTE et al., 2010). It is a proven educational model that provides contextualized opportunities offered in an experiential format that successfully prepares
graduates for the demands of citizenship, college, and careers (Brand, 2009). Since 1998, when the SCANS recommendations were included in CTE legislation and funding (H.R. 1853, 1998), non-cognitive (soft) skills have been integrated into the technical curriculum as an avenue to prepare students for the workplace, internships, and apprenticeships.

Modern CTE programs differ significantly from the outdated perception of traditional vocational education which was thought to be only for those who were not college-bound. Today, CTE teaches rigorous academics, employability, and technical skills; offers dual college credit and internship opportunities; and leads students directly to college (ACTE et al., 2010). According to the U.S. Department of Education, Office of Vocational and Adult Education (2010), almost every high school student takes at least one CTE course in high school and, for those who take one or more CTE courses, dropout rates are lower and achievement rates are higher (Kemple & Scott-Clayton, 2004; Wonacott, 2002).

The 2006 Carl D. Perkins Career and Technical Education Improvement Act (Perkins IV), which provides federal funding for CTE nationwide, defined CTE as “organized educational activities that offer a sequence of courses that provides individuals with coherent and rigorous content aligned with challenging academic standards and relevant technical knowledge and skills needed to prepare for further education and careers in current and emerging professions” (U.S. Department of Education, 2006, p. 4). CTE courses do this by emphasizing the link between academic and technical knowledge, while providing opportunities for skills application through career-technical instruction. This integrated approach to skills mastery creates a connection that helps prepare students for a successful postsecondary career or college
experience (ACTE et al., 2010; Brand, 2009). In layman’s terms, CTE programs connect challenging technical courses with demanding academics while reinforcing non-cognitive skills. This prepares students for a range of careers and educational opportunities in high demand professions (Institute for a Competitive Workforce, 2008).

CTE classes are sequenced into programs of study that provide an increasingly rigorous technical curriculum. Advanced courses feature field opportunities where students have the opportunity to apply skills mastered in the classroom (Kazis, 2005). Because CTE classes are frequently taught by an industry professional with education and experience in the field of study, CTE classrooms often parallel a business environment with high expectations for student accountability, rigor, and responsibility (Reese, 2010). This classroom experience aptly prepares students to move into an internship setting, where they can receive immediate feedback for their behavior, skills, and decision-making ability from industry professionals (Kazis, 2005), providing a foundation for successfully managing postsecondary expectations.

In many cases, CTE classes are tightly aligned with a post-secondary credit granting institution such that students are concurrently enrolled in high school and college classes, earning dual credit for their above average achievement in advanced CTE coursework (ACTE et al., 2010). Often called “tech prep,” classes are provided through a collaborative agreement between local high schools and postsecondary institutions, offering aligned curriculum in a comprehensive pathway to meet both the high school and college requirements (Dare, 2006). These opportunities are designed to help students develop confidence in a post-secondary educational setting and encourage them to seek additional postsecondary educational options (ACTE et al., 2010; Meeder, 2008).
Today, policymakers, industry leaders, and educational professionals agree that there is a set of skills that high school students must acquire in order to be well prepared for life in the 21st Century (Association for Career & Technical Education, National Association of State Directors of Career & Technical Education Consortium, and Partnership for 21st Century Skills, 2010; North Central Regional Educational Laboratories, 2009; NGACBP et al., 2008; Partnership for 21st Century Education, 2004). Both employers and post-secondary faculty agree that this battery of 21st Century skills is necessary for postsecondary success in both college and the workforce and that high school graduates arrive at their doors unequipped (Carnevale, 2008; Conley, 2007a; Olson, 2007). Career and technical education professionals argue that CTE provides a solid framework and well-documented pathway for preparing all students with the 21st Century skills necessary for life success (ACTE et al., 2010).

**Integration of twenty-first century skills.** As originally noted in the SCANS report (U.S. Department of Labor, 1992), the five skill sets examined here are dynamic in their application and spill over arbitrarily assigned boundaries (Lai & Viering, 2012). For example, while the categories of communication and interpersonal skills can be represented separately, they have also been successfully combined under the umbrella of interpersonal communication, collaboration, or teamwork. The same can be said for the many common descriptors that connect the five categories. Such language as self-worth, positive attitude, personal management, flexibility, and adaptation, is a common thread in and amongst all five categories. This strengthens and reinforces the SCANS findings, as well as subsequent research results that suggest that skills and qualities that comprise a 21st Century skills set do not occur in isolation but must applied in a collaborative
context in order to be truly learned (Lai & Viering, 2012; U.S. Department of Labor, 1999).

Carnevale (2008) asserted that this overlap of skills within categories plays a positive role in the process of preparing students for postsecondary success in all venues because “general competency leavens all subsequent learning” (p. 9). This is further supported by the purpose of school, as represented in the U.S. Department of Labor’s *Learning a Living Report* (SCANS) (1992), which stated, “they prepare people to live full lives – to participate in their communities, to raise families, and to enjoy the leisure that is the fruit of their labor” (p. 5). Career and technical education reflects the importance of integrated skills attainment through a commitment to an environment that “involves students in the construction of knowledge by engaging them in authentic tasks of the workplace” (Brown, 2003). To truly meet the needs of today’s constantly connected, instant gratification generation, 21st Century skills education must be tied to and applied to outcomes (Kay, 2010; West Virginia Department of Education, 2008b). Adequate and appropriate preparation will rely heavily on the ability of today’s educators to focus on those outcomes, teach students the skills associated with 21st Century success, and provide contextualized opportunities to practice and apply acquired skills before graduating from high school (Kay, 2010).

**Reliability and Validity**

Measurement provides the foundation for all scientific discoveries that have consequently changed applied practices (Meehl, 1978; O’Donohue, 1989). More important than the measurement, however, is the ability to evaluate whether the data obtained from the instrument are of any value in the first place (Cone & Forster, 1991).
Researchers agree that one of the problems with educational research relates to poor measurement (Wright, 1997; Andrich, 2002; Bond & Fox, 2001), particularly the inability to accurately quantify latent, or indirect traits. Educational stakeholders are increasingly calling for scientifically-based research which provides replicability and evidence of the evolution of knowledge over time. This requires research methods that demonstrate evidence of validity and of achieving good measurement properties for the construct, rather than relying just on the observation of raw scores (Coleman, 2006).

What follows is a discussion of the techniques used for establishing instrument reliability and validity, followed by a discussion of established factor analysis methods. These techniques and methods define best practices for determining reliability and validity. The explanation of these techniques and methods informs the review of literature and methodology for the current study.

Reliability. Reliability, the measure of consistency or repeatability of an instrument, is also necessary for a strong validity argument (Carmines & Zeller, 1979; Sprinthall, 2007). Measures of reliability reflect the relationship among the instrument items, specific groups of participants, and the application context of the measurement tool (AERA et al., 1999). While it is not possible to calculate an exact reliability, four general methods are used to estimate reliability in different contexts (Sprinthall, 2007). These are inter-rater, test-retest, parallel-forms, and internal-consistency reliability. Each method has advantages and disadvantages, as well as yielding a different value.

Inter-rater reliability is the degree to which “different raters/observers give consistent estimates of a common phenomenon” (Trochim, 2006b, p. 1). Stated differently, it is a measure of reliability across different people using the same test and is
frequently used where human observation presents an opportunity for bias. When the measurement consists of categories of observation, inter-rater reliability is obtained by calculating the percent of agreement between different observers. When the measure is a continuous scale, inter-rater reliability is obtained by calculating the correlation between the rating outcomes (Trochim, 2006b). One common measure is Cohen’s Kappa which provides a score ranging from 0.0 to 1.0 in which a lower score indicates that differences were a result of chance (Wood, 2007). Stemler (2004) suggested that a more accurate representation of inter-rater reliability can be made by classifying results into three category estimates: 1) consensus, 2) consistency, and 3) measurement. Consensus estimates assume that scorers can come to an agreement regarding the application of rubric levels to observed behaviors. This is measured using percent-agreement. Consistency estimates assume that observers do not have to interpret the rating scale the same way, as long as each consistently applies the scale to observed phenomena. This is commonly measured using the Pearson correlation coefficient. Measurement estimates rely on all the information provided by the observers to create a summary score. Principal component analysis, a factor analytic technique, is commonly used for this estimate (Stemler, 2004).

A second method of establishing reliability is the test-retest method which measures consistency from one administration of an instrument to a second administration (Key, 1997; Sprinthall, 2007; Trochim, 2006b). This assumes that no substantial change in the test occurs between the first administration and subsequent measured administrations (Trochim, 2006b). Considered to be one of the easiest and most intuitive reliability techniques, the direct correlation between the time interval
between tests and the reliability rating must also be considered (Key, 1997; Sprinthall, 2007). The practice effect, which suggests that some of the respondents spent the time between test administrations thinking or studying to better answer the questions, can lead to differences that are not random (Sprinthall, 2007). As well, the effects of fatigue, often found in instances where the time interval is too short and respondents are tired or bored, can lead to differences in results (Sprinthall, 2007). A correlation coefficient appropriate for the type of data being collected is the statistical measure used to determine test-retest reliability (Rummel, 1976).

Parallel-forms reliability is a third method of testing reliability that assesses the consistency of results between two tests constructed in the same form from the same content items with the same level of difficulty (Sprinthall, 2007; Trochim, 2006b). This can be done by developing a large set of questions addressing the same construct and then, by random division, create two instruments for administration to the same population (Trochim, 2006b). The test results are correlated to provide an estimate of reliability. Considerations when using parallel-forms reliability include the large number of test items that must be created, the assumption that the two tests, upon random division, are equivalent measures, and that the interval between test administrations is sufficient to prevent fatigue (Sprinthall, 2007; Trochim, 2006b). Again, the statistically appropriate correlation coefficient would be chosen to determine parallel-forms reliability (Rummel, 1976).

A fourth method of reliability testing is called internal-consistency reliability. This method assesses the consistency of results across items within a test, judging the reliability of the instrument based on consistency of results among items measuring the
same construct (Trochim, 2006b). This can be achieved by calculating an inter-item correlation, an item-total correlation, a split-half reliability test, or Cronbach’s alpha (α) (Trochim, 2006b). Inter-item correlation compares correlation means between all items measuring the same construct. Item-total correlation uses the inter-item correlations to compute a total score for all items, which becomes an additional variable. In split-half reliability testing, items measuring the same construct are randomly split in half and compared to each other using a Spearman-Brown prophecy formula (Sprinthall, 2007). Finally, using Cronbach’s alpha (α), items are split repeatedly and the correlations recomputed for each split until all possible split-half estimates have been examined, yielding a mathematical average (Sprinthall, 2007; Trochim, 2006b). In all cases, a scale of 0.0 to 1.0 is used. Scores closer to 1.0 generally indicate that the null hypothesis of no correlation can be rejected (Rummel, 1976; Sprinthall, 2007).

Each of these four methods has different uses. For observation data, inter-rater reliability is generally used (Heffner, 2004). For experimental and quasi-experimental designs, test-retest estimation is most feasible (Trochim, 2006b). Parallel-forms is considered appropriate where two equivalent instruments can be used to measure the same thing with the same respondent population at different times (Sprinthall, 2007). Internal consistency most frequently uses the coefficient, alpha, which is designed for use with tests that have no right answer but, rather, ask respondents to agree or disagree with a statement (Key, 1997). The choice of analysis methods should be carefully considered based on the specific research being conducted (Trochim, 2006b).

Validity. “For a test to have any practical use, it must not only be reliable, but it must also be valid” (Sprinthall, 2007, p. 514). According to the Standards for
Educational and Psychological Testing (1999), validity is defined as “the degree to which all of the accumulated evidence supports the intended interpretation of test scores for the intended purpose” (American Education Research Association, American Psychological Association & National Council on Measurement in Education, 1999, p.11). More simply stated, it is the degree to which an instrument measures what it is supposed to measure (Key, 1997). When developing assessments and using subsequent data gathered from them, validity is a fundamental consideration (AERA, et al., 1999) and a necessary condition if the test is to be used to make inferences based on those scores (AERA, et al., 1999; Cizek, Bowen & Church, 2010; Messick, 1989).

Review of validity theory reveals a focus on three types of validity: content, criterion, and construct validity (Cizek, n.d.). Content validity, sometimes characterized as non-statistical, is based on logic and common sense to determine whether test items represent the general domain that it was designed to evaluate (Sprinthall, 2007). To establish this type of validity, the domain to be represented must be identified and items randomly chosen to accurately represent it (Key, 1997). For example, if a test is supposed to measure student knowledge of biomes, it should be reflective of items identified in that domain and not scored on the basis of writing traits, neatness, or creativity. Criterion validity is concerned with calibrating the instrument against a known standard or determining the presence or absence of one or more criteria representing the trait of interest (Key, 1997). Two types of criterion validity, concurrent and predictive, measure whether an instrument is being tested against an independent criterion (Sprinthall, 2007). When test scores are compared with an already established, accepted measure of the theory under study, it is known as concurrent validity. When an instrument is tested over
time to determine the degree to which is can be used to predict future behavior or performance, it is called predictive (Heffner, 2004; Sprinthall, 2007).

Because modern validity theory focuses on supporting the interpretations or inferences to be made from assessment data with regard to the theory being studied, all validity can be considered construct validity (Cizek, n.d.). A construct is a label that defines an attribute or behavior, most often unobserved, that an individual might be assumed to possess, such as integrity. Construct validity is used when no criterion or content is accepted as fully adequate to describe the quality being measured (Key, 1997). Evaluation of construct validity consists of two parts, a consideration of the underlying theory and the adequacy of the test used to measure the construct. While other validity techniques can be accomplished through singular correlational studies, construct validity requires a series of studies and evidence gathered through multiple tests aimed at identifying the underlying trait (Sprinthall, 2007). Establishing construct validity first involves defining the variable or trait being measured. Next, data concerning the trait must be collected and compared with data from the instrument to determine convergence (similarity). Finally, it must be demonstrated that the construct is unique and can be differentiated from other traits (Key, 1997). This process is done through the process of factor analysis (Sprinthall, 2007).

When determining validity, the Standards for Educational and Psychological Testing (AERA, et al., 1999) identified five sources of evidence. This evidence is based on test content, response processes, internal structure, relationships to other variables, and consequences of testing. The first source of evidence, also called content validity, is based on test development processes, bias review, vetting procedures, and alignment
A second source of evidence is based on the processes a respondent goes through while responding to test items which represent cognitive behaviors (Cizek, n.d.). This can be done through items that ask respondents to show their work, as well as interviewing respondents as they work through test items (AERA, et al., 1999). Internal structure, or the underlying framework of a test instrument, provides further evidence to support validity. For example, an analysis of disaggregated test outcomes into sub-scores or strands can determine whether a collection of items supports inferences about a distinct knowledge or skill (Cizek, 2009). As well, statistical methods such as factor analysis can be used to evaluate dimensionality and homogeneity of a set of items (AERA, et al., 1999). Correlation data often provides a fourth source of evidence based on relationships of variables to one another. This data is found in one of two criterion-related forms, concurrent or predictive (Sprinthall, 2007). Finally, the consequences of testing, and whether the intended use of the scores were realized, can be used as evidence of validity. This type of evidence is sometimes described as consequential validity (Cizek, Bowen, & Church, 2010). The source of evidence that is most appropriate for a specific instrument is logically derived from the proposed interpretation and the purpose of the measure (Downing, 2003).

**Validity evidence based on internal structure.** When developing an instrument, opportunities for validity evidence collection are available through item construction procedures (test content), pilot administration responses (response processes), and other test construction processes (Cizek, 2009). The instrument in this study was developed prior to the study, making it necessary to choose a method to provide validity evidence, such as internal structure, to support the theorized measurement of the specified latent
traits, 21st Century skills. There is limited discussion of validity evidence based on internal structure in the literature, as most primary research involving measurement of latent traits presents evidence of reliability, using Cronbach’s alpha, as the argument validating an instrument’s internal structure (Hogan & Agnello, 2004). Hogan and Agnello explained this by saying that “reliability, especially internal consistency reliability…is easier to obtain than is validity information” (2004, p. 808-9).

Internal structure as a source of validity evidence refers to the degree to which the relationship between items or between underlying factors or inter-item relationships are consistent with the construct (AERA et al., 1999). This means that items or sets of items that are intended to measure the same variable are more highly related than scores intended to measure different variables (Downing, 2003). Internal structure also refers to the dimensionality of an instrument, as well as item functioning which includes individual item functioning, item-total functioning, inter-item correlations, differential item functioning (DIF), and the ability of items to explain the theorized continuum of the construct (AERA et al., 1999; Coleman, 2006).

Dimensionality refers to the nature, scope, and ideology of an instrument based on the hypothesized theoretical construct (Hopkins, 2002). It is important because it provides a framework from which to understand the construct and make inferences (Smith & McCarthy, 1995). For instance, if student 21st Century skills attainment is theorized to exist in four dimensions, then confirmation or rejection of that structure will influence the inferences researchers are able to make about student scores using the instrument. It is important to consider the theoretical foundation of an instrument prior to performing statistical analysis in order to distinguish whether the purpose of the analysis
is to provide evidence to support a theory or if the analysis is being used to determine the
construct (Coleman, 2006). In most research, analysis to provide evidence for a theory is
preferred. The exception to this may be those cases in which the knowledge about the
instrument or construct is so lacking that researchers must look to statistical methods,
such as factor analysis, to provide guidance in building theory (Smith & McCarthy,
1995).

Internal consistency, a measure of reliability, allows researchers to conduct an
empirical investigation of the item-total and inter-item correlations using the mean
among items to determine an estimate of internal consistency based on a single
administration of an instrument from one sample (Carmines & Zeller, 1979). Item-to-
total and inter-items correlations establish that the indicators of the construct being studied
are functioning as they should, statistically. As such, where collinearity is anticipated,
some degree of correlation between items and between individual item scores would be
expected. Similarly, in items deemed non-collinear, a lack of correlation would be
expected (Gorsuch, 1997). Items with inadequate or unexpected correlations give
researchers cause to question the item functioning and consider that they may represent
something different than the theorized construct (Coleman, 2006).

Differential item functioning (DIF), which refers to bias, must also be assessed as
part of the evidence collection process for internal structure. According to the Standards
(1999), DIF “occurs when different groups of examinees with similar overall ability, or
similar status on an appropriate criterion, have, on average, systematically different
responses to a particular item” (AERA et al., 1999, p. 13). Said another way, DIF is
present if an item consistently reflects large between-group differences while
concurrently exhibiting small within-group differences. This may indicate that the item is biased and may need to be modified (Coleman, 2006). However, it should be noted that the variations in performance can sometimes be explained based on the relationship of the specific test content or task to the conceptual framework, in which case DIF is not deemed detrimental to the argument for validity (AERA et al., 1999).

Choosing which of these pieces of evidence should be used to evaluate an instrument’s internal structure is based on the assumptions that must be met for validity, particularly the hypothesis regarding the function of the instrument and the intended inferences that might be drawn from the scores (Cizek 2009; Downing, 2003). Frequently, inter-item relationships are used to provide estimates of score reliability which are then used as a proxy for validity evidence (AERA et al., 1999). It is important to note, however, that inter-item correlations provide only a lower bound estimate of validity.

**Factor Analysis**

Factor analysis is recognized as a useful technique for establishing validity evidence based on the internal structure of an instrument (Harmon, 1976). First developed in the early 19th century by Charles Spearman, factor analysis describes the underlying structure that explains a set of variables, capitalizing on the extent to which measurement overlap exists (also known as shared variability) (Mertler & Vanatta, 2008). In simplest terms, factor analysis is a process of variable reduction by determining which variables cluster together to measure a common construct (Mertler & Vanatta, 2008).

The procedures associated with factor analysis involve a series of methodological steps which require informed decision-making by the researcher. Because of the inherent
subjectivity of the decisions at each step which can directly impact the inferences made from an instrument, factor analysis procedures are regarded as highly vulnerable for misuse (Henson & Roberts, 2006; Kieffer, 1999). For this reason, it is critical that researchers accurately and concisely report each step, providing justification for the specific choices made, which enables evaluation and potential replication of the research design. Literature identifies five necessary elements that should be carefully considered when planning and reporting factor analysis procedures: 1) Factor model and estimation method; 2) Sample size; 3) Factor extraction; 4) Rotation criteria; and 5) Factor retention (Reise, Waller & Comrey, 2000).

**Factor analyses models.** Factor analysis is a general term that is used to represent the process of extracting or reducing variables (DeCoster, 1998). In factor analysis, shared variability is analyzed without considering unique or error variability (Stapleton, 1997; Stevens, 2001). There are two types of factor analyses: exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). Exploratory factor analysis, the most common form of factor analysis, seeks to identify the latent variables, or factors, influencing a set of responses (DeCoster, 1998). The researchers’ assumption, in this case, is that any indicator may be associated with any factor. EFA seeks to estimate an error-free factor solution, limiting analysis to common variance shared between observed variables (Stevens, 2001). Confirmatory factor analysis is used to test a developed hypothesis that a specified set of constructs is influencing responses in a particular way (DeCoster, 1998). It requires a larger data set than EFA and is more difficult to perform. However, it can be used as a follow up to CFA if a different set of data is available for the same instrument. Both types of analysis are based on the model
of common factor analysis that posits that “each observed response is influenced partially by underlying common factors and partially by underlying unique factors” (DeCoster, 1998, p. 1).

A commonly used factor-extraction technique is principal component analysis. Principal component analysis is defined as a “method of transforming a given set of variables into a new set of composite variables or principal components that are orthogonal (uncorrelated) to each other” (Nie, 1975, p. 470). The procedure determines the linear combination of variables that best accounts for variance in the data, as a whole, by analyzing all sources of variability (unique, shared, and error). In this scenario, the first component provides the strongest indication of linear relationships in the data. The second component is viewed as providing the best linear combination of variables “that accounts for the most residual variance after the effect of the first component is removed from the data (Nie, 1975, p. 470). Operating under the condition of orthogonality – that each factor is independent from the others - this means that the second component accounts for the proportion of variance that is not represented in the first component. The same understanding can be applied to subsequent factors, until all variance in the data is represented. The solution generally requires as many components as there are variables, unless one variable is perfectly determined by the others. However, the first several components that emerge generally explain most of the variance in the data and the researcher must determine how many should be retained for further rotation.

Sample size criteria. With regard to appropriate sample size and rules that govern sample size for factor analysis, there is a marked lack of consensus (Reise, Waller, & Comrey, 2000). “It is not possible to make blanket recommendations
regarding this issue without considering other important aspects of design” (MacCallum, Widamen, Zhang, & Hong, 1999, p. 636). In general, larger sample sizes are thought to produce better results and be more stable across sampling (DeVellis, 2003). Though no recommendation is deemed appropriate for all studies, existing rules reference both overall sample sizes, as well as participant-to-variable ratios (Guadagnoli & Velicer, 1988; MacCallum & Tuciker, 1991; MacCallum, et al. 1999).

Bryant and Yarnold (1995) suggested a sample size that is five times greater than the number of variables. Stevens (2001) provided recommendations based on the number of variables per component and their associated loadings. Mertler & Vanatta (2008) suggested, as a general rule of thumb, that a data set that includes at least 300 cases has an accurate estimated reliability, citing guidelines from Tabachnick and Fidell (2007). Further, Tabachnick and Fidell stated that solutions containing several high loading marker variables (> .80) can be considered sufficiently reliable with a smaller sample size, such as n = 150. These researchers provided general rather than specific guidelines for sample size criteria and suggested that the final determination is best left to the discretion of the researcher.

**Extraction.** Extraction is a reduction process that seeks to identify the number of common factors that will accurately account for the variance among total items. While there is no rule regarding how many factors should be extracted and retained for further analysis, the final number of factors is important. If too few factors are extracted, it is possible to miss important distinctions among items and the resulting rotation may be skewed. If too many factors are extracted, the rotated factors may be poorly defined, yielding only one or two factors with prominent loadings (Reise et al., 2000). Generally,
research findings have supported that it is preferable to extract too many factors, rather than too few, as studies have shown that underextraction yields factors that contain considerably more error than when factors are overextracted (Wood, Tataryn, & Gorsuch, 1996).

Due to the lack of clarity about the number of factors to extract, it is critical that researchers support their decisions with evidence. There are several methods of extraction that can be used including principal axis factoring, alpha factoring, maximum likelihood estimation, scree tests and parallel analysis, and generalized least squares. Principal axis factoring is commonly used for data with a non-normal distribution (Costello & Osborne, 2005). Alpha factoring assumes randomly sampled variables (Giancarlo, Blohm, & Urdan, 2004). Maximum likelihood uses a statistical criterion to determine the number of factors to extract, applying the goodness-of-fit statistic to test the null hypothesis of no discrepancy between observed and predicted correlation (DeVellis, 2003). Scree tests seek to visually locate a distinct break on the plot between the steep descending linear trend of the large factors and the gradual leveling out of the remaining factors (Taachnick & Fidell, 2007). A parallel analysis uses random data to plot the same thing, using the point where the two plots meet to determine the maximum number of factors that should be extracted (Reise et al., 2000). Finally, generalized least squares is a method suitable for categorical and ordinal level data (Norris & Lecavalier, 2010). In selecting an extraction method, the level of measurement for the items should act as the primary criterion.

**Rotation.** Rotation analysis is the practice of adjusting initial extraction results, which produce difficult to interpret orthogonal variables, to an interpretable simple
structure. Simple structure implies that each item is highly loaded on one or two factors, while the rest of the items have a low or zero loading (Thurstone, 1947). Through rotation, factor solutions can be transformed without altering the underlying structure (Mertler & Vanatta, 2008). Because there are many statistically equivalent ways to define the underlying dimensions of a data set, there are no generally accepted best solutions to be gained from rotation but, rather, researchers are tasked with determining best fit. This is accomplished by examining rotation solutions and determining which best satisfies the theoretical and practical needs of the research problem at hand.

Researchers primarily use one of two categories of rotation: Orthogonal or Oblique (Mertler & Vanatta, 2008). Orthogonal rotation results in factors being uncorrelated with one another and provides, as output, a loading matrix that reflects the size and extent of the relationship between observed variables and each factor. However, oblique rotation results in correlated factors. Three matrices result from this type of rotation: a correlation matrix with correlated items; a pattern matrix which shows unique relationships among items with no overlap; and a structure matrix, which shows correlations between factors and items. Mertler & Vanatta (2008) stated that, “because the goal of factor analysis is to obtain underlying factors that are uncorrelated (thereby representing some unique aspect of the underlying structure), it is recommended that orthogonal rotation be used instead of oblique” (p. 238).

Three types of orthogonal rotation are widely used: varimax, quartimax, and equamax. Varimax rotation, most commonly used, is a method of rotation that minimizes factor complexity by maximizing the variance for each factor. Quartimax rotation maximizes variance loading on each item in order to minimize factor complexity.
Equamax rotation neither maximizes or minimizes the variances of factors over variables but uses a combination of both varimax and quartimax procedures. Upon interpretation of these results, terminal factors can be identified and named (Mertler & Vanatta, 2008).

**Factor retention.** Upon extraction and rotation of factors, researchers are tasked with determining how many factors to retain in the factor solution. Four common methods of determining which factors to retain are Kaiser criterion, scree plotting, those that account for 70% of total variability, and assessment of best fit. The Kaiser criterion utilizes eigenvalues, which represent the amount of variance captured by the individual factor, and purports that those with values greater than one indicate the factor explains more variance than one single item and should be retained. This rule has been found to be accurate when applied to data sets where the original number of variables is \( n > 250 \) and the mean communality is greater than .60. While this is a popular practice and often the default criterion in statistical software packages, there is an argument that this is the least accurate method to determine retention, often overestimating the number of factors (DeVellis, 2003; Reise et al., 2000; Zwick & Velicer, 1986).

A second method is the examination of the scree plot, a graphical representation of the magnitude of each eigenvalue in descending order (Mertler & Vanatta, 2008). The factors that fall on the vertical slope are retained as valuable and those that fall on the horizontal slope are discarded as valueless scree (Comrey & Lee, 1992; DeVellis, 2003; Stevens, 2001). This method is known to provide fairly accurate results where \( n > 250 \), provided that most communalities are greater than .30. Though the scree test is considered less variable than the Kaiser criterion, it also tends to overestimate the number of factors for retention (Zwick & Velicer, 1986).
A third criterion is to retain and interpret as many factors as will account for a specific amount of total variance, generally at least 70% of total variability (Stevens, 2001). While there may be situations where a greater percentage of variability is desired, this may not always be feasible. Since the goal of factor analysis is to reduce the number of variables to identify an underlying structure, if achieving 70% total variability requires the majority of the components, little has been gained. Additionally, this scenario probably reflects factors that are variable-specific such that only one component loads on a given factor. This does not contribute to the purpose of discovering structures for the combination of original components (Mertler & Vanatta, 2008).

A final criterion is the assessment of best fit in which the reproduced correlations are computed and compared with the original, observed correlations. If the number of relatively close correlations (within .05 of each other) is small, signifying that all of the reproduced and observed correlations are close to each other, there is an assumption that the model is consistent with the empirical data. “In other words, the model ‘fits’ the data” (Mertler & Vanatta, 2008, p. 198). To determine which factors should be retained for rotation, all four criteria must be weighed against the overall goal of the analysis (Mertler & Vanatta, 2008).

**Recent factor analysis studies.** There are many studies that have utilized factor analysis to provide evidence of validity for a survey instrument. For the purpose of this research, the field of literature was narrowed to those studies that examined an instrument currently in use, rather than one that was being developed by the researcher. Two recent studies were closely examined based on parallels in their methodology and purpose, a 2011 study by Turk-Fiecoat, and a 2006 study by Coleman.
Turk-Fiecoat (2011) used factor analysis to test the construct validity of a widely used survey instrument that purported to measure student satisfaction and perception of value with student union facilities. Using factor analysis to establish construct validity, Turk-Fiecoat used a principal component factor analysis and various extraction methods to identify 5 constructs from the 56 scaled items of the existing survey. This was followed by a cluster analysis to determine inter-relationships between student satisfaction and perception of value. Turk-Fiecoat’s findings indicated that although several survey items and at least one construct were not supported by the data, the instrument was valid overall. These findings also suggested that review of specific survey items should be conducted to strengthen the data being gathered by the survey instrument as it relates to the constructs being measured.

In 2006, Coleman conducted a study of construct validity to compare the Rasch measurement to confirmatory factor analysis (CFA) and exploratory factor analysis (EFA) as a means of establishing construct validity. Coleman’s study utilized an existing multi-scale instrument used to measure middle and high school students’ motivation. Using factor analysis and employing multiple extraction methods (principle axis factoring, unweighted least squares, generalized least squares, maximum likelihood estimation, and alpha factoring), Coleman found that the three methods of Rasch modeling yielded corroborating yet different evidence at the unidimensional level. This supported the practice of using common factor analysis to estimate the degree of unidimensionality of a construct prior to subjecting it to the Rasch model. Coleman’s results further the study of conjoint tool use to determine construct validity.
Several other studies also provided insight for the current study based on their methodology, purpose, and findings. Bailey-Jones (2008) used principal component analysis with varimax rotation to determine the reliability and underlying factors of an existing survey by comparing results from two administrations of the survey. The results identified four factors from among the original 28 variables through this process. Worley (2006) used principal axis factoring to determine the internal consistency of an existing instrument in three different forms on 3 pre-determined constructs. The results indicated unidimensionality on all three versions of the survey instrument. Smith (2003) looked at three different instruments that purported to measure the same three factors to determine which measured those factors best. A confirmatory factor analysis followed by a post-hoc factor analysis revealed that the instruments reliably measured only two of the three factors.

Summary

“Only people who have the knowledge and skills to negotiate constant change and reinvent themselves for new situations will succeed,” said Ken Kay, president of the Partnership for 21st Century Skills, “Competency in 21st Century skills gives people the ability to keep learning and adjusting to change” (Kay, 2010, p. xvii). As important as these skills are thought to be, there are limited resources with which to measure student acquisition of soft skills (Carnevale & Desrochers, 2003). While there are a variety of tools under development and in use to measure student acquisition of these skills, there are none that provide a research-based, reliable, and efficient method of measurement for large scale implementation. In the absence of a reliable tool, many schools are relying on academic data augmented with student self-assessment data to predict student readiness
for postsecondary success (Conley, 2007b, 2010). There is little evidence to suggest that the self-assessments being used are measuring what stakeholders believe them to be measuring.

Twenty-first century “soft” skills, sometimes referred to as functional skills or non-cognitive skills, include such things as job seeking, communication, problem solving, critical thinking, and business skills. These skills were first identified in a report of the U.S. Department of Labor Secretary’s Commission on Achieving Necessary Skills. Today, mastery of the 21st Century soft skills identified in that report is considered to be the ticket to upward mobility in the 21st Century economy (Gewertz, 2007). Career and technical education has emerged as one pathway that prepares students for postsecondary success through an integrated curriculum of academic and technical skills, with a focus on 21st Century skills development.

This chapter provides the framework for the research which proposes to determine the reliability and validity of an instrument currently in use to measure 21st Century skills acquisition. It examines instruments that are currently available, as well as examining established methodology for determining validity and reliability. It provides an understanding of 21st Century skills and the importance of those skills in the postsecondary venues of college and career. The following chapter will provide details of the methodology to be used in this study. Chapters four and five will outline the results found in the study, as well as explore interpretations of the data.
CHAPTER III

Current high school graduates are expected to possess a specific set of non-academic, critically important competencies known as 21st Century skills in order to be successful in all postsecondary venues. This postsecondary demand represents a significant shift in focus which requires educational leaders to examine the tools used to provide evidence of 21st Century skills mastery, as well as evaluate the contexts in which 21st Century skills are taught and learned. To date, little research has been conducted to suggest a connection between specific pathways or pedagogies that may contribute to the attainment of a 21st Century skills set. As well, little research has emerged regarding how to measure these types of non-academic, often non-cognitive, skills. This study examined the validity of an instrument currently used with high school students to measure 21st Century skills attainment. As well, the research explored the relationships that existed among response based on student membership in specific demographic groupings.

This chapter details the methodology of the study. It is organized into four sections: (a) purpose of the study, (b) instrumentation, (c) data acquisition, (d) data analysis procedures. The first section of the chapter details the problem addressed and the purpose of the study, providing a review of the research questions of the study. The second section presents a description of the instrument. The third section includes an examination of the primary data acquisition process and the characteristics of the participants and the school. The final section describes the data analyses procedures that were followed in conducting the research. These descriptions are provided in order to develop a framework for the study and allow future researchers to build upon it.
Problem and Purpose

The changing demand for the types of skills high school students must possess upon graduation requires that educational leaders examine tools that can provide evidence that those skills have been mastered. As well, they must begin examining the educational contexts that are most conducive to mastery. To date, little research has emerged regarding how to best measure 21st Century skills attainment or which tools might be used for reliable data gathering.

The purpose of this study was to determine the reliability and validity of a survey instrument used to measure high school students’ perceptions of 21st Century skills mastery in specific areas. A secondary, inferred intent was to determine if the instrument could be modified to meet the standards of reliability and validity in the event that the original instrument was not found to be valid. Additionally, the study sought to determine differences in student perceptions based on membership in specific demographic groups. The first portion of the research, guided by specific research questions, sought to examine the empirical factors evident in the survey, along with their congruence with the developer’s original intent. As well, the reliability of those factors and the correlation of each to the others were examined. The final research question sought to explore the differences in student perceptions of 21st Century skills mastery based on demographic group membership. The demographic groups examined were Gender, Ethnicity, Socio-economic Status, High School Zone, and Program of Study. The information and insights provided by this research are intended to be used to guide curriculum and instructional strategies in future CTE programs.
Instrumentation

The survey examined for this study was a modified version of a 1988 self-assessment instrument developed by SkillsUSA as part of the Professional Development Program (PDP), a student curriculum taught in high school and college CTE programs. SkillsUSA, a national career and technical organization, serves high school and college students enrolled in career and technical education courses. The organization provides leadership, citizenship, and professional development experiences to students as a complement to the technical training curriculum (SkillsUSA, 2004).

The PDP and the instrument have undergone three revisions since the original development, the most recent revision in 2004 (Davies, 2011). The instrument, as designed by SkillsUSA, contains 12 categories of skills deemed necessary to meet the demands of the workplace based on findings of the U.S Department of Labor in the Secretary’s Commission on Achieving Necessary Skills (SCANS) report (U.S. Department of Labor, 1990). These 12 categories included academic skills such as math, reading, and writing as they apply in the workplace, as well as skills related to obtaining and maintaining a job such as career development skills, work activity skills, economic skills, and thinking skills. Within each category, specific related tasks are presented for which students’ rate their competency on a scale of one to three.

The instrument uses a paper and pencil format and is part of a PDP unit. The unit is taught at the conclusion of each school year after students have experienced, discussed, and practiced many of the skills listed as part of the curriculum. The purpose of the instrument, as identified in the PDP documentation, is to help students assess their own skills attainment in various program competencies. The assessment’s results can be used
as part of portfolio development, which provides evidence of skills students believe they have acquired (SkillsUSA, 2004).

In 2008, the instrument was modified at an individual school to include only those skills thought to be reflective of 21st Century skills acquisition. From the original 12 categories, the school extracted five related to perceptions of student attainment of skills needed to obtain and maintain a job. These were followed by 55 questions assessing individual tasks (variables) on a scale of one to five, where one represents ‘I have not been taught this yet’ and five represents ‘I am really good at this.’ Each question identified a separate variable to be considered in the factor analysis. The instrument also included nine questions related to learning style and student achievement which were considered beyond the scope of this study.
Although the SkillsUSA self-assessment is a widely-used instrument, no empirical data about the instrument was available (M. Davies, personal communication, Sept. 15, 2011). With regard to validity of the instrument, the factor analysis conducted as part of this study was used to establish empirical factors and calculate reliabilities of those factors (Stapleton, 1997).

**Data Acquisition**

This study utilized existing data collected at the school during the routine annual program evaluation process of the school and district. Data collection was performed by the staff at the school from which the data was acquired. Student respondents completed the “paper and pencil” survey through web based technology. Raw data was forwarded to the Chief School Accountability Officer at the main district office. Upon approval
from the University of Nevada, Reno, Institutional Review Board and the school district, deidentified data were acquired directly from the main district office.

**Setting.** The school from which the data was collected was a specialty high school the focused on providing students access to multiple career and technical education pathways. At the time the data was collected, the school was completing the second year of transition from a school that provided services for only 11th and 12th graders, to a comprehensive high school serving grades 9 through 12 with a focus on providing multiple career and technical education pathway alongside academic coursework. At the time of the study, students in grades 9 and 10 were attending the school to earn both their academic credits and their CTE pathway credits with the intent to graduate from the school. These students had gone through a rigorous application and screening process in order to enroll in the school. Students in grades 11 and 12 were attending the school for a portion of the day to receive only CTE instruction. These students accessed academic coursework at a different school from which a diploma could be earned. These students also applied to attend the school to enroll in advanced CTE courses and were accepted based on prior experience in their CTE pathway, as well as availability of space.

**Data.** The student data was collected in May, 2011. The respondent population totaled 396 students attending a small CTE high school in the western United States. Of those, 183 students attended with the purpose of completing an advanced CTE course and approximately 213 students attended the same school with the purpose of completing a 4-year program of study in a specific CTE field. Demographic groupings, for the purpose
of this study were delineated by five criteria: Gender, Ethnicity, Socio-economic Status (SES), High School Zone, and Program of Study.

**Gender.** The data for Gender indicated that 173 respondents were male and 223 respondents were female (Table 1). Therefore, 43.7% of the 396 respondents were male and 56.3% of participants were female.

Table 1

*Summary of Frequencies and Percentages for Groups Established by Gender*

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>173</td>
<td>43.7%</td>
</tr>
<tr>
<td>Female</td>
<td>223</td>
<td>56.3%</td>
</tr>
<tr>
<td>Total</td>
<td>396</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

**Ethnicity.** Ethnicity groups were established based on the criteria provided by the school district. Table 2 summarizes this data. The data indicated 88 respondents identified as Hispanic (22%), 4 respondents identified as American Indian/Alaska Natives (1%), 21 respondents identified as Asian (5%), 6 respondents identified as Black/African American (2%), and 21 respondents identified as having 2 or more races (5%). The remaining 256 respondents were identified as white (65%).
Table 2

*Summary of Frequencies and Percentages for Groups Established by Ethnicity*

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hispanic/Latino</td>
<td>88</td>
<td>22%</td>
</tr>
<tr>
<td>American Indian/Alaska</td>
<td>4</td>
<td>1%</td>
</tr>
<tr>
<td>Native</td>
<td>21</td>
<td>5%</td>
</tr>
<tr>
<td>Asian</td>
<td>6</td>
<td>2%</td>
</tr>
<tr>
<td>Black/African American</td>
<td>256</td>
<td>65%</td>
</tr>
<tr>
<td>White</td>
<td>21</td>
<td>5%</td>
</tr>
<tr>
<td>2 or More Races</td>
<td>396</td>
<td>100%</td>
</tr>
</tbody>
</table>

**High school zone.** Student data was disaggregated by the high school that students were anticipated to attend based on the geographical area in which they lived. It was further grouped into four administrative zones, as designated by the school district in which the research took place. A summary of this demographic data is presented in Table 3.
Table 3

Summary of Frequencies and Percentages for Groups Established by Geographic High School Area

<table>
<thead>
<tr>
<th>Geographic High School Area (1-10)</th>
<th>Frequency</th>
<th>Percent</th>
<th>Administrative High School Zone (1-4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>36</td>
<td>9%</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>17</td>
<td>4%</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>19</td>
<td>5%</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>45</td>
<td>11%</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>40</td>
<td>10%</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>50</td>
<td>13%</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>75</td>
<td>19%</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>20</td>
<td>5%</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>48</td>
<td>12%</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>46</td>
<td>12%</td>
<td>2</td>
</tr>
</tbody>
</table>

Socio-economic Status. Using each respondent’s designation for geographic high school area, groups were established based on Socio-economic Status (SES). For each school, this was determined by using the state designation for students qualifying for the federal free and reduced lunch (FRL) program in the 2010-11 school year. The Elementary and Secondary Education Act, Title 1, part A, determines high poverty schools to be those with 40% or more of the overall student population from low-income families (U.S. Department of Education, 2003). The federal free and reduced lunch program criteria is widely used as a proxy for poverty rates in federal program eligibility
(Moore, Hulsey & Ponza, 2009). For the purposes of this study, high schools reporting 40\% or more students qualifying for free and reduced lunch were designated as low SES. Student respondents associated with that high school were similarly designated as low SES. High schools reporting 39\% or less students qualifying for free and reduced lunch were designated as high SES. Student respondents associated with that high school were similarly designated as high SES. Respondents were placed in either the high or low SES group based on the geographical high school area groups, as discussed earlier. This data is summarized in Table 4.

Table 4

*Summary of Frequencies and Percentages for Groups Established by Socio-economic Status*

<table>
<thead>
<tr>
<th>Geographical High School Area (1-10)</th>
<th>Frequency of Free &amp; Reduced Lunch (FRL)</th>
<th>Socio-economic Status (SES) Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24.1%</td>
<td>High</td>
</tr>
<tr>
<td>2</td>
<td>23.1%</td>
<td>High</td>
</tr>
<tr>
<td>3</td>
<td>99.4%</td>
<td>Low</td>
</tr>
<tr>
<td>4</td>
<td>14.9%</td>
<td>High</td>
</tr>
<tr>
<td>5</td>
<td>34.6%</td>
<td>High</td>
</tr>
<tr>
<td>6</td>
<td>22.7%</td>
<td>High</td>
</tr>
<tr>
<td>7</td>
<td>15.5%</td>
<td>High</td>
</tr>
<tr>
<td>8</td>
<td>61.0%</td>
<td>Low</td>
</tr>
<tr>
<td>9</td>
<td>23.6%</td>
<td>High</td>
</tr>
<tr>
<td>10</td>
<td>44.7%</td>
<td>Low</td>
</tr>
</tbody>
</table>
**Program of study.** Seven groups were established for the Program of Study variable based on the CTE course in which each respondent was enrolled. Each class was assigned to a category as part of an overall course of study designation given by the research school. Group membership varied from 6.8% of the overall respondents to 27.3% of the overall respondents. A summary of this data is provided in Table 5.

Table 5

*Summary of Frequencies and Percentages for Groups Established by Program of Study*

<table>
<thead>
<tr>
<th>Program of Study</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>36</td>
<td>9.1%</td>
</tr>
<tr>
<td>Business</td>
<td>32</td>
<td>8.1%</td>
</tr>
<tr>
<td>Communication Arts</td>
<td>108</td>
<td>27.3%</td>
</tr>
<tr>
<td>Culinary</td>
<td>52</td>
<td>13.1%</td>
</tr>
<tr>
<td>Education</td>
<td>27</td>
<td>6.8%</td>
</tr>
<tr>
<td>Engineering</td>
<td>61</td>
<td>15.4%</td>
</tr>
<tr>
<td>Medical</td>
<td>80</td>
<td>20.2%</td>
</tr>
<tr>
<td>Total</td>
<td>396</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

**Data Analysis Procedures**

**Research question 1.** The instrument in this research featured a large number of variables (55) and a moderately large sample size (396), as defined by Comrey, Reise & Waller (2000), as well as an absence of any empirical data. For the purpose of this research, the instrument was assumed to have an interval scale based on the attributes of
the data, as well as the presence of at least five categories (Allen & Seaman, 1997). Therefore, factor analysis was chosen as the appropriate analysis.

Factor analysis can be used to establish validity based on the internal structure of an instrument (Harman, 1976). It is a process of data reduction by determining which items cluster together to measure a common construct (Mertler & Vanatta, 2008). In this study, the statistical software program, Predictive Analytic Software (PASW), was selected to conduct a Factor Analysis on the survey items to determine if a preponderance of evidence existed to identify underlying constructs.

**Research question 2.** Cronbach’s alpha was chosen to determine whether the items in the test instrument provided a measure of internal consistency and reliability. To complete this analysis, items identified as contributing to any identified factors in research question 1 would be tested for reliability. A reliability analysis could then be conducted for each of the identified factors using only the items that had been found to contribute to that factor.

**Research question 3.** To determine correlations among factors, Pearson’s correlation coefficient $r$ was chosen. By calculating a mean factor score from the data obtained in research question 2, a Pearson’s $r$ could be calculated to indicate the degree to which the identified factors related to one another. This statistical test does not describe the relationship, but rather verifies the presence of a relationship, expressed as a correlation coefficient ranging from -1.00 to 1.00. The Pearson $r$ was deemed the appropriate analysis based on the assumption of interval data and a linear relationship.

**Research question 4.** To determine if differences existed among the identified demographic groups (Gender, Ethnicity, Socio-economic Status, High School Zone, and
Program of Study) and the factors identified in research question 1, one-way multivariate analysis of variance (MANOVA) was selected as the appropriate statistical analysis. Appropriateness of this analysis was based on Mertler & Vanatta’s definition of factors and the items that contribute to them: a) Factors consist of different measures of the same construct; b) Items that contribute to a factor share a common conceptual meaning; and c) Items contributing to a factor make sense as a group (2008). Use of MANOVA allows for a holistic analysis of the differences based on the factors.

For each of the demographic groups, a separate MANOVA would be conducted to generate a Box’s M statistic to evaluate to test for homogeneity of variance-covariance. If the assumption of homogeneity of variance-covariance is met, Wilks’ Lambda can be interpreted for significance. If the assumption is not met, Pillai’s Trace can be interpreted for significance. Where significance is found, an appropriate post hoc test, such as a T-test or Tukey’s HSD, can be conducted to determine where and to what magnitude differences existed.

**Summary**

This study used the acquired data, as described, and the data analysis procedures outlined in order to reach conclusions regarding the research questions. This chapter acts as an overview and description of the data, as well as the procedural explanation for the methodology to be employed in the study. The following chapter provides specific details about how the analysis of data was performed and what results were obtained (chapter IV). The final chapter discusses the significance of the findings with relationship to the research questions, as well as the implications for application and further study.
CHAPTER IV

The primary purposes of this study were to establish reliability and validity of a survey instrument that had been used to gather information about the perceptions of acquired levels of 21st Century skills (see definition on p. 13) mastery among high school students enrolled in Career & Technical Education (CTE) classes. A secondary purpose was to explore relationships among responses based on student membership in specific demographic groupings.

The survey instrument under study was a modified version of a self-assessment instrument developed by SkillsUSA as part of the Professional Development Program (PDP) taught in high school and college CTE programs. The self-assessment, originally developed in 1988, was revised three times by SkillsUSA, the most current revision in 2004. The assessment was revised by school personnel in 2008 to be administered in an electronic survey format. At the time of this study, it had been used in the new format for two years and had been administered to students three times. The instrument asked students to rate themselves on areas of 21st Century skills acquisition: Job Seeking & Career Development, Communication Skills, Interpersonal Skills, Problem Solving & Reasoning Skills, and Business & Economic Skills. Each subscale is associated with specific questions for a total of 55 items. Each item was measured using a scale of one to five, where 1 represented “I have not been taught this yet” and 5 represented “I am really good at this.”

The purpose of this chapter is to present the data analysis results to address the research questions:
1. Given the sample of the study, what are the empirical factors for the survey instrument? To what extent are the empirical factors congruent with the original factors established by the developers of the instrument? (Factor Analysis)

2. Given the empirical factors established in Question 1, what are the reliabilities of all items that contribute to each factor? (Reliability)

3. Do relationships exist among the various factors based on the responses from the study? (Correlation)

4. Are the perceptions of various groups, as established by the demographic variables, different on the subscales of the survey? Of specific interest are groups established by Gender, Ethnicity, School Zone, Program of Study, and Socio-economic Status. (Multivariate Analysis of Variance)

Respondent Data

This study utilized existing data collected by a small CTE high school in the western United States. In the 2010-11 school year, the assessment instrument was administered to students during class time as a component of a routine annual program evaluation cycle. A web-based delivery system was utilized. Raw data were forwarded to the Chief School Accountability Officer of the district office. Upon approval from the University of Nevada, Reno, Institutional Review Board and the school district, deidentified data was acquired directly from the main district office with permission of the Chief School Accountability Officer.

A total of 409 student responses were collected. Of that number, 97% or 396 surveys were complete. The 14 incomplete responses were removed from this study. For
the purposes of this study, demographic groupings were delineated by five criteria: Gender, Ethnicity, Socio-economic Status (SES), High School Zone, and Program of Study.

**Descriptive Statistics**

Data for each student respondent included the following variables: Gender, Ethnicity, High School Zone, Socio-economic Status, and Program of Study. A discussion, along with tables summarizing the frequencies and percentages of each demographic group, can be found in Chapter 3. For the demographic variables of Ethnicity, High School Zone, and Socio-economic Status, data was reorganized into fewer representative groups for the purpose of this study. A discussion of those groups established for analysis follows.

**Ethnicity.** Table 2, found in Chapter 3, summarizes the frequencies and percentages for six groups established by ethnicity. For this variable, only two ethnicity groups were established to represent White (n = 256) and Non-White. The non-white category included Hispanics (n = 88), which accounted for 63%. Also included in this category were Black/African Americans (n = 6, 4%), Asians (n = 21, 15%), American Indian/Alaska natives (n = 4, 3%), and those reporting two or more races (n = 21, 15%). Together, those included in the non-white category that were identified as non-hispanic accounted for the remaining 37% (n = 52) of the category. Frequency and percentage data is summarized in Table 6. The data indicate that 140 respondents were identified as non-white (35.4%), while 256 respondents were identified as white (64.6%).
Table 6

*Summary of Frequencies and Percentages for Groups Established by Two Ethnicity Groups*

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>256</td>
<td>64.6%</td>
</tr>
<tr>
<td>Non-White</td>
<td>140</td>
<td>35.4%</td>
</tr>
<tr>
<td>Total</td>
<td>396</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

**High school zone.** Table 3, found in Chapter 3, summarizes the frequencies and percentages for ten geographic high school areas. From this data, four groups were established for this demographic variable based on the administrative zones determined by the school district. A definition of these zones can be found in Chapter 1. Table 7, below, summarizes the frequencies and percentages by zone which were used to conduct the statistical analyses for this study. In Zone 1, 96 respondents accounted for 24.2% of the overall total. In Zone 2, 66 respondents accounted for 16.7% of the overall total. In Zone 3, 173 respondents accounted for 43.7% of the overall total. In Zone 4, 61 respondents accounted for 15.4% of the overall total.
Table 7

*Summary of Frequencies and Percentages for Groups Established by High School Zone*

<table>
<thead>
<tr>
<th>High School Zone</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1</td>
<td>96</td>
<td>24.2%</td>
</tr>
<tr>
<td>Zone 2</td>
<td>66</td>
<td>16.7%</td>
</tr>
<tr>
<td>Zone 3</td>
<td>173</td>
<td>43.7%</td>
</tr>
<tr>
<td>Zone 4</td>
<td>61</td>
<td>15.4%</td>
</tr>
<tr>
<td>Total</td>
<td>396</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

**Socio-economic Status (SES).** Table 4, found in Chapter 3, summarizes the frequencies and percentages for each geographic high school area. From these areas, each school was placed in one of two socio-economic groups, high or low, which were established for this demographic variable based on the state designation for students qualifying for the federal free and reduced lunch (FRL) program in the 2010-11 school year (see discussion in Chapter 3). The data indicating frequencies and percentages for SES are summarized in Table 8. The data indicated that 310 respondents were zoned for high schools with a high SES designation, reflecting 78.3% of the overall respondents. The remaining 86 respondents were zoned for high schools with a low SES designation, reflecting 21.7% of overall respondents.
Table 8

*Summary of Frequencies and Percentages for Groups Established by Socio-economic Status*

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>High SES</td>
<td>310</td>
<td>78.3%</td>
</tr>
<tr>
<td>Low SES</td>
<td>86</td>
<td>21.7%</td>
</tr>
<tr>
<td>Total</td>
<td>396</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

**Data Analysis**

This section presents the results of data analysis for each of the four research questions. Factor analysis was conducted for question one. A reliability analysis using Cronbach’s alpha was computed for question two. A correlation matrix was computed for question three. Various multivariate analysis of variances (MANOVA), along with the corresponding post hoc analyses where appropriate, were conducted for question four.

**Research question 1.** Given the sample of the study, what are the empirical factors for the survey instrument? To what extent are the empirical factors congruent with the original factors established by the developers of the instrument?

To determine the empirical factors of the survey instrument, as well as the congruence with original factors established by the developers, a principal component factor analysis was conducted using all 55 items from original instrument. Initially, eight potential factors were identified, which accounted for 64.93% of the total variability. This value indicates the appropriateness of the use of factor analysis (Mertler & Vanatta, 2008). The data were further pared down through repeated factor analyses and evaluated for best fit. Five factors were identified as representative of underlying constructs of the
instrument and 31 test items were retained that significantly contributed to the constructs. The following discussion details the data analysis procedure that supported these findings.

**Pre-analysis data screening.** Data was first examined for missing values. This analysis indicated that no data was missing from any of the items (variables). This was followed by testing for univariate outliers. Finally, univariate normality was assessed.

Multivariate outliers were discovered by calculating Mahalanobis Distance using all 55 quantitative items. The $\chi^2_{\text{crit}} (\text{df} = 55)$ was 92.129 ($p < .001$), which resulted in the identification of 43 cases that exceeded the critical chi-square. These cases represented more than 10% of the study sample; thus, the removal would have a significant effect on the result (Mertler & Vanatta, 2010). Additionally, upon examination of the cases individually, an unbalanced representation of cases in the demographic grouping, Program of Study, was identified such that respondents in Communication Arts would be reduced by 20.4%, respondents in Education would be reduced by 18.15%, respondents in Engineering would be reduced by 13%, and respondents in Business would be reduced by 9%. The remaining three Programs of Study would be reduced by less than 2% each. These two conditions, as well as the relative importance of understanding why specific students rate themselves far lower in certain areas than do other students, provided the justification for the decision not to eliminate any of these cases. Nine outliers were also identified in this process. They were not transformed based on an assumption that the extremes they reflected may be representative of the student population that career and technical education serves.
Due to the large number of items, multivariate linearity and normality were
difficult to assess using a scatterplot matrix. Rather, univariate tests were conducted even
though assumptions regarding the distribution of variables are not really in force when
factor and principal component analysis are being used in a descriptive manner and
MANOVA is robust to violations of univariate normality (Mertler & Vanatta, 2010).
Using Kolmogorov-Smirnoff, each item was evaluated for normality and in all cases, the
null hypothesis of normality was rejected. Skewness and kurtosis for each item were also
evaluated, looking for values between -1.0 and +1.0 which would indicate that variables
were reasonably close to normal. Only 8 of the 55 items showed skewness or kurtosis
over 1.0 in either direction. However, all items showed a negative skew and almost all
items reflected skewness above .400. It was determined that data transformation would
not be conducted in this case due to the robustness to non-normality of subsequent tests
(Mertler & Vanatta, 2010).

**Factor Analysis.** A principal component factor analysis was initially conducted
to determine if distinct factors emerge. Principal component analysis establishes the best
linear combination of variables that account for more of the variance than any other linear
combination (Nie, 1975). Operating under the condition of orthogonality, the first
component provides the strongest summary of linear relationships in the data, followed
by the second component, which accounts for the most residual variance after the effect
of the first variable is removed. Principal component analysis is based on an assumption
that observed correlations are the result of underlying regularities (Nie, 1975).

Principal component analysis provides an eigenvalue measure for each factor.
Eigenvalues greater than 1 are considered to represent strong factors (Mertler & Vanatta,
Eight potential factors, accounting for 64.93% of the total variability, were identified. These findings are summarized in Table 9. An analysis of communalities revealed that the majority had a value greater than .70 with a mean communality was .652. Examination of the scree plot showed between 4 and 6 components in the sharp descent of the line before the leveling effect occurred.

Table 9

Factor Analysis Total Variance Explained

<table>
<thead>
<tr>
<th>Factor</th>
<th>Initial Eigenvalues</th>
<th>Total Variance Explained</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Factor Total</td>
</tr>
<tr>
<td>1</td>
<td>23.058</td>
<td>41.923</td>
</tr>
<tr>
<td>2</td>
<td>3.277</td>
<td>5.958</td>
</tr>
<tr>
<td>3</td>
<td>2.289</td>
<td>4.163</td>
</tr>
<tr>
<td>4</td>
<td>1.857</td>
<td>3.377</td>
</tr>
<tr>
<td>5</td>
<td>1.484</td>
<td>2.698</td>
</tr>
<tr>
<td>6</td>
<td>1.358</td>
<td>2.470</td>
</tr>
<tr>
<td>7</td>
<td>1.278</td>
<td>2.323</td>
</tr>
<tr>
<td>8</td>
<td>1.108</td>
<td>2.015</td>
</tr>
</tbody>
</table>

To determine the number of factors to retain, each of the criteria results were examined and weighed against the goal for parsimony (Mertler & Vanatta, 2008). In this research, an argument to retain all eight factors could be made because the rule has been shown to be accurate when the eigenvalues are greater than 1, N > 250, and mean communality is greater than .652 (Mertler & Vanatta, 2008). As well, an argument could be made to retain the 4 to 6 factors in the sharp descent of the line as shown in the scree plot. When N > 250, this is considered to yield fairly accurate results provided most communalities are >.30, as in this case (Mertler & Vanatta, 2008). A third consideration
was to retain as many factors as necessary to account for 70% of total variability (Stevens, 2001). In this case, 11 factors made up 70% of the variability; however, three had an eigenvalue less than 1. A final consideration was the number of categories included in the original instrument. Because five categories were originally represented, which was fairly consistent with the result of the scree test, it was determined that forced factor rotations with four, five, and six factors would be conducted to determine a best fit model.

In order to further examine various factor solutions, factor analyses were conducted forcing four, five, and six factors to find the most parsimonious set of factors. Common practice dictates using multiple tests with varying number of factors, communality estimates, or rotational methods until the researcher identifies a preferred solution (Tabachnick & Fidell, 2007). For this research, subsequent tests included relevant combinations of extraction methods and data rotations including Unweighted Least Squares, Generalized Least Squares, Principal Axis Factoring, Alpha Factoring, and Maximum Likelihood. For each, orthogonal rotation methods of quartimax, varimax, and equamax were applied to derive unique solutions. The rotated factor matrix for each solution was evaluated for best fit by examining eigenvalues greater than one, scree plot analysis, factors accounting for the greatest percentage of variability, and consideration of the number of categories included in the original instrument. As well, each solution was compared to all others to determine which model was a best fit. Factor loadings on each rotated factor matrix were considered to appropriate using a criteria of highest loading being greater than .45 or higher on one factor (representing 20% variance overlap) while loading at .33 or less (representing less than 10% variance overlap) on the
second highest factor (Comrey & Lee, 1992). Meeting these criteria was considered to be a high factor loading.

Rotations forcing four factors accounted for 52-53% of cumulative variance for factors with eigenvalues greater than one. Rotations forcing five factors accounted for 54-55% of cumulative variance and rotations forcing six factors accounted for 56-57% of cumulative variance. In the initial analysis of the rotated solutions, those that revealed a high percentage of variance on the first factor followed by low variance represented by the remaining factors were removed. These solutions were primarily quartimax rotations forcing five and six factors. In the subsequent analysis of the remaining solutions, significant factor loadings and distribution of high factor loadings among factors were considered. Those that showed an unbalanced distribution of high factor loading among factors or that revealed more moderate factor loadings were removed. These solutions were primarily varimax rotations forcing four factors. Finally, the remaining nine solutions were evaluated using all of the criteria already applied, as well as examining congruence with the number of categories in the original survey, to determine best fit. With five factors selected, the equamax rotation using the generalized least squares method was chosen as the best fit, producing at least three high and pure loadings on all factors.

**Generalized least squares with equamax rotation.** Generalized least squares is a factor analysis method used to determine best fit of variables to a generalized linear model. Equamax rotation was used to combine procedures used for both varimax and quartimax methods, minimizing factor complexity by maximizing the variance for each factor (varimax) while also maximizing variance loadings on each variable in order to
minimize factor complexity (quaritmax). After rotation, the cumulative variance accounted for was 55.54%; each of the five identified factors accounted for variance ranging from 9.953% to 12.62% (see Table 10). When considering the initial eigenvalues, this percentage of total variance was determined to be acceptable. Within each factor, the number of items reflecting a high load on each ranged from 4 to 10.

Table 10 summarizes the results of the rotation.

Table 10

<table>
<thead>
<tr>
<th>Factor</th>
<th>Number of Items Loading High</th>
<th>Initial Eigenvalue</th>
<th>Percentage of Variance Accounted for by the Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>23.058</td>
<td>12.62%</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>3.277</td>
<td>11.90%</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>2.289</td>
<td>10.95%</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>1.857</td>
<td>10.12%</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>1.484</td>
<td>9.95%</td>
</tr>
</tbody>
</table>

Total Variance Explained

55.54%

The rotated solution yielded five interpretable factors. The next step in the analysis was to determine which items reflected a high loading with respect to individual factors. A complete table of the resulting factor matrix can be found in Appendix A. Utilizing the same criteria for the highest loading (> .45) and the second highest loading (< .33), 24 of the 55 items were discarded because they did not meet these criteria (see Appendix B). The remaining 31 high loading items were examined in the context of the associated factor to determine face validity of each of the factors.
Face validity is based on an examination of a test to determine whether it has the look and feel of the construct it is intending to measure (Sprinthall, 2007). For this research, the content of each of the items contributing to an individual factor was examined to determine which 21st Century construct the group of items appeared to measure. These items were then compared to one another and to the category name assigned by the test developers to determine congruency among and between each item and the factor it represented. From this examination, the following factor names were given to best describe the underlying construct: Factor 1 (Job Seeking Skills), Factor 2 (Communication Skills), Factor 3 (Collaboration Skills), Factor 4 (Problem Solving & Reasoning Skills), and Factor 5 (Economic Skills). Table 11 presents a list of survey items associated with each factor.
### Table 11

**Factor Names and Corresponding Items Retained with Primary Factor Loading**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Items</th>
<th>Primary Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Job Seeking Skills</strong></td>
<td>Accurately complete a follow-up letter</td>
<td>.848</td>
</tr>
<tr>
<td></td>
<td>Accurately complete inquiry letter</td>
<td>.748</td>
</tr>
<tr>
<td></td>
<td>Accurately complete a resume</td>
<td>.641</td>
</tr>
<tr>
<td></td>
<td>Accurately complete a job application</td>
<td>.632</td>
</tr>
<tr>
<td></td>
<td>Identify career goals</td>
<td>.520</td>
</tr>
<tr>
<td></td>
<td>Complete an interview without errors</td>
<td>.462</td>
</tr>
<tr>
<td><strong>Communication Skills</strong></td>
<td>Answer questions accurately</td>
<td>.562</td>
</tr>
<tr>
<td></td>
<td>Speak distinctly</td>
<td>.549</td>
</tr>
<tr>
<td></td>
<td>Use appropriate vocabulary &amp; grammar</td>
<td>.528</td>
</tr>
<tr>
<td></td>
<td>Explain activities &amp; ideas clearly</td>
<td>.495</td>
</tr>
<tr>
<td></td>
<td>Ask questions</td>
<td>.488</td>
</tr>
<tr>
<td><strong>Collaboration Skills</strong></td>
<td>Work cooperatively on a team</td>
<td>.889</td>
</tr>
<tr>
<td></td>
<td>Work cooperatively with classmates</td>
<td>.852</td>
</tr>
<tr>
<td></td>
<td>Work cooperatively with adults</td>
<td>.573</td>
</tr>
<tr>
<td></td>
<td>Exercise patience &amp; tolerance</td>
<td>.465</td>
</tr>
<tr>
<td><strong>Problem Solving &amp; Reasoning Skills</strong></td>
<td>Formulate alternative approaches</td>
<td>.685</td>
</tr>
<tr>
<td></td>
<td>Select efficient approaches</td>
<td>.656</td>
</tr>
<tr>
<td></td>
<td>Evaluate an activity</td>
<td>.648</td>
</tr>
<tr>
<td></td>
<td>Collect information</td>
<td>.644</td>
</tr>
<tr>
<td></td>
<td>Interpret information</td>
<td>.644</td>
</tr>
<tr>
<td></td>
<td>Review progress</td>
<td>.635</td>
</tr>
<tr>
<td></td>
<td>Organize information</td>
<td>.600</td>
</tr>
<tr>
<td></td>
<td>Prepare materials or equipment</td>
<td>.594</td>
</tr>
<tr>
<td></td>
<td>Knowledge of accessing resources</td>
<td>.569</td>
</tr>
<tr>
<td></td>
<td>Identify procedures</td>
<td>.539</td>
</tr>
<tr>
<td><strong>Economic Skills</strong></td>
<td>Understand the production process</td>
<td>.864</td>
</tr>
<tr>
<td></td>
<td>Understand the marketing process</td>
<td>.853</td>
</tr>
<tr>
<td></td>
<td>Understand business costs</td>
<td>.838</td>
</tr>
<tr>
<td></td>
<td>Understand business competition</td>
<td>.823</td>
</tr>
<tr>
<td></td>
<td>Understand factors affecting profit</td>
<td>.818</td>
</tr>
<tr>
<td></td>
<td>Understand business organization</td>
<td>.760</td>
</tr>
</tbody>
</table>
**Factor scores.** Factor scores for each respondent were created for each of the five identified factors. For each factor, the mean of the survey items identified as having high loadings were calculated into one overall score. Thus, for factor one, the scores from the six items that contributed to the factor were averaged to create a factor mean for each respondent. For the purpose of this study, the results from the survey instrument and subsequent factor analysis are assumed to be approximately continuous; therefore, parametric calculations were chosen for further analysis.

**Research question 2.** Given the empirical factors established in question 1, what are the reliabilities of the items that contribute to each factor?

To determine the reliabilities of the empirical factors established in question 1, a reliability analysis using Cronbach’s coefficient alpha was conducted using the items (n = 31) identified in the factor analysis. A reliability score was calculated for each factor using only the items determined to be contributing to each, as identified in research question 1. Finally, new factor scores were calculated for each respondent based on the mean of only the items determined to be contributing to those factors. A final reliability analysis was conducted using these scores. Each of these analyses indicated reliability. The discussion that follows describes the data analysis procedures that led to these findings.

**Reliability.** Internal consistency, a measure of how closely items in a group are related, was examined for each individual factor, for sets of items contributing to each factor, and mean overall factors using Cronbach’s alpha. Cronbach’s alpha is commonly used to determine the internal consistency or average correlation of items in a survey instrument in order to conclude whether the items will elicit consistent and reliable
responses (Santos, 1999). It is an index associated with measurement of the hypothetical variable, underlying construct (Hatcher, 1994). Nunnaly (1978) indicated that 0.7 is an acceptable threshold of reliability on the 0 to 1 coefficient range for dichotomous and multi-point questionnaires.

For the 31 individual items, the reported alpha was $\alpha = .953$. The computed alpha for Factor 1: Job Seeking Skills, containing 6 items, was $\alpha = .854$. The computed alpha for Factor 2: Communication Skills, containing 5 items, was $\alpha = .839$. The computed alpha for Factor 3: Collaboration Skills, containing 4 items, was $\alpha = .798$. The computed alpha for Factor 4: Problem Solving & Reasoning Skills, containing 10 items, was $\alpha = .933$. The computed alpha for Factor 5: Economic Skills, containing 6 items, was $\alpha = .953$. For the five factor scores, calculated from the mean of each item within that factor, the reported alpha was $\alpha = .835$. Using Nunnaly’s standard of reliability for social research, $\alpha > .70$, it can be concluded that the results obtained for each reliability analysis indicates a high reliability among the new empirical factors identified. Table 12 summarizes these analyses.
Table 12

*Summary of Cronbach’s Alpha Reliability Scores*

<table>
<thead>
<tr>
<th>Test of All Items</th>
<th>Number of Items</th>
<th>Cronbach’s Alpha (α)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test of Factor 1: Job Seeking Skills</td>
<td>6</td>
<td>.854</td>
</tr>
<tr>
<td>Test of Factor 2: Communication Skills</td>
<td>5</td>
<td>.839</td>
</tr>
<tr>
<td>Test of Factor 3: Collaboration Skills</td>
<td>4</td>
<td>.798</td>
</tr>
<tr>
<td>Test of Factor 4: Problem Solving &amp; Reasoning Skills</td>
<td>10</td>
<td>.933</td>
</tr>
<tr>
<td>Test of Factor 5: Economic Skills</td>
<td>6</td>
<td>.798</td>
</tr>
</tbody>
</table>

Research question 3. Do relationships exist among the various factors based on the responses from the study?

To determine if relationships existed among the various identified factors based on the responses, a correlation analysis was conducted. Correlation seeks to determine a joint association between variables such that two variables regularly occur together or, when changes in one set of events occurs, it regularly accompanies changes in another set of events (Sprinthall, 2007). Pearson’s product moment correlation coefficients ($r$) were computed across the various factors identified in question one. Correlation coefficients range from 0 to 1. The farther the score is from zero, the stronger the relationship between the two variables. The reported Pearson $r$ for each of the five factors indicated a positive (direct) correlation with each of the other factors. A discussion of the data analysis methods follows.
Pearson product-moment correlation coefficients $r$ were computed to determine relationships among the five identified factors (see Table 12). Pearson $r^2$ correlation coefficient indicates the proportion of variance that is shared by both variables, measured on a -1.0 to 1.0 continuum. The reported Pearson $r$ were statistically significant ($p < .01$) in all cases. The strongest correlations existed between Factor 4: Problem Solving and Factor 2: Communication Skills ($r = .683$, $p < .01$). Coupled with a significant probability value well below the conventional threshold and the coefficient of determination of $r^2 = .466$ (which indicates the percent of variation), the relationship between scores can be considered moderate (Taylor, 1990).

Factor 2 correlation also revealed a relationship between Factor 1: Job Seeking Skills ($r = .576$, $p < .01$; $r^2 = .330$) and Factor 3: Collaboration Skills ($r = .553$, $p < .01$; $r^2 = .305$). Factor 2 also showed a relatively weak relationship with Factor 5: Economic Skills ($r = .468$, $p < .01$; $r^2 = .219$), the correlation coefficient is below .500, which indicates a relatively weak correlation. In each of these cases, the coefficients of determination were below .50 ($r^2 < .50$). Combined with a probability of $p < .01$, indicating that the probability of being wrong in an assumption of relatedness is almost non-existent, the relationship between Factor 2 and Factors 1 and 5 can be considered moderate, as well.

The weakest correlation evident in the analysis of Pearson’s $r$ is between Factor 3: Collaboration Skills and Factor 5: Economic Skills ($r = .350$, $p < .01$; $r^2 = .122$). Because this correlation coefficient is well below .500, it can be viewed as a weak relationship. Table 13 summarizes the correlation results.
Table 13

Summary of Pearson’s Product-Moment Correlation Coefficient (r) Among Five Factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Job Seeking Skills</th>
<th>Communication Skills</th>
<th>Collaboration Skills</th>
<th>Problem Solving Skills</th>
<th>Economic Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job Seeking Skills</td>
<td>1.000</td>
<td>.576**</td>
<td>.493**</td>
<td>583**</td>
<td>.584**</td>
</tr>
<tr>
<td>Communication Skills</td>
<td></td>
<td>1.000</td>
<td>.553**</td>
<td>.683**</td>
<td>.468**</td>
</tr>
<tr>
<td>Collaboration Skills</td>
<td></td>
<td></td>
<td>1.000</td>
<td>.546**</td>
<td>.350**</td>
</tr>
<tr>
<td>Problem Solving Skills</td>
<td></td>
<td></td>
<td></td>
<td>1.000</td>
<td>.584**</td>
</tr>
<tr>
<td>Economic Skills</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.000</td>
</tr>
</tbody>
</table>

**Correlation is significant at the .01 level (2-tailed).

Research question 4. For students who have completed a CTE course, are the perceptions of various groups, as defined by demographic variables, different on factor subscales of the survey instrument? Of specific interest are groups established by Ethnicity, Gender, Socio-economic Status, High School Zone, and Program of Study.

In determining perception differences on the factors based on demographic group membership, five separate multivariate analyses of variance (MANOVA) were conducted, one for each demographic category: Ethnicity, Gender, Socio-economic Status (SES), Zoned High School, and Program of Study. A total of 396 respondents were used for each analysis. The data analysis processes and the results of the various MANOVAs are discussed below.

Multivariate analysis of variance. A one-way multivariate analysis of variance (MANOVA) was conducted for each group identified by demographic designation in order to determine if differences existed based on factor means. When significance was
found, appropriate post hoc testing was conducted using univariate pairwise comparisons, Tukey’s HSD, or a t-test. The type of post hoc testing was determined by the number of categories included in the demographic designation.

Five demographic designations were used to establish groups: Ethnicity, Gender, Socio-economic Status (SES), High School Zone, and Program of Study. The demographic group, Ethnicity, was defined by two categories, white \((n = 256)\) and non-white \((n = 140)\). The group titled Gender was also defined by two categories, male \((n = 173)\) and female \((n = 223)\). The group with the demographic designation, SES, was defined by two categories, high \((n = 310)\) and low \((n = 86)\), based on the overall percentage of students qualifying for free and reduced lunch at the respondents zoned high school. The groupings for High School Zone were based upon the respondents’ zoned high school and categorized using the division determined by the host school district. There are four identified categories in this group: 1 \((n = 96)\), 2 \((n = 66)\), 3 \((n = 173)\), and 4 \((n = 61)\). Finally, the grouping for Program of Study was defined by the 7 career areas in which respondents completed coursework: Agriculture \((n = 36)\), Business \((n = 32)\), Communication Arts \((n = 108)\), Culinary \((n = 52)\), Education \((n = 27)\), Engineering \((n = 61)\) and Medical \((n = 80)\).

**Ethnicity.** A one way MANOVA was conducted to determine if differences existed between Ethnicity categories, white and non-white, based on the mean survey responses of the five factor scores. The assumption of homogeneity of variance-covariance was met (Box’s M > .001); therefore, Wilks’ Lambda was used as the appropriate test statistic. The main effect revealed no statistical significance \([\text{Wilks’}\Lambda = .982, F(5, 390) = 1.410, p > .01]\) and effect size was small \((\eta^2 = .018)\). This can be
interpreted to mean that ethnicity had no effect on responses for any of the five factor subscales.

**Gender.** A one way MANOVA was conducted to determine if differences existed between *Gender* categories, male and female, based on the mean survey responses of the five factor scores. The assumption of homogeneity of variance-covariance was met (Box’s M > .001); therefore, Wilks’ Lambda was the appropriate test statistic. The main effect revealed a statistical significance [Wilks’Λ = .962, F(5, 390) = 1.410, p < .01] and effect size was small (η² = .038). However, examination of the main effects revealed no statistical significance [F(1,394) values ranged from .025 to 3.506, p > .01 in all cases]. The effect size was small (η² < .02) in all cases. Post hoc analyses were conducted for each factor. Results indicated that gender had a cumulative effect on all factors, but no effect on a specific factor between gender categories (male and female) on the five factor scores (Cook, 2010). Table 14 summarizes the results of the one-way ANOVA.
Table 14

*Univariate Main Effect Results for Gender Groups on Five Factor Scores*

<table>
<thead>
<tr>
<th>Variable</th>
<th>df</th>
<th>ms²</th>
<th>F</th>
<th>Sig</th>
<th>η²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job Seeking Skills</td>
<td>1</td>
<td>.476</td>
<td>.743</td>
<td>.389</td>
<td>.002</td>
</tr>
<tr>
<td>Error</td>
<td>394</td>
<td>.640</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication Skills</td>
<td>1</td>
<td>.010</td>
<td>.025</td>
<td>.874</td>
<td>.001</td>
</tr>
<tr>
<td>Error</td>
<td>394</td>
<td>.389</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collaboration Skills</td>
<td>1</td>
<td>1.151</td>
<td>3.506</td>
<td>.062</td>
<td>.009</td>
</tr>
<tr>
<td>Error</td>
<td>394</td>
<td>.328</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Problem Solving Skills</td>
<td>1</td>
<td>.480</td>
<td>1.367</td>
<td>.243</td>
<td>.003</td>
</tr>
<tr>
<td>Error</td>
<td>394</td>
<td>.351</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic Skills</td>
<td>1</td>
<td>2.870</td>
<td>2.837</td>
<td>.093</td>
<td>.007</td>
</tr>
<tr>
<td>Error</td>
<td>394</td>
<td>1.012</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Socio-economic Status (SES).* A one way MANOVA was conducted to determine if differences existed between SES categories, high and low, in the mean survey responses of the five factor scores. The assumption of homogeneity of variance-covariance was met (Box’s M >.001); therefore, Wilks’ Lambda was used as the appropriate test statistic. The results indicated no statistical significance [Wilks’Λ = .982, F(5, 390) = 1.558, p > .01] and effect size was small (η² = .02). This can be interpreted to indicate that SES had no effect on responses for any of the five factor subscales.
**High school zone.** A one way MANOVA was conducted to determine if differences existed between High School Zone categories in the mean survey responses of the five factor scores. The assumption of homogeneity of variance-covariance was met (Box’s M > .001); therefore, Wilks’ Lambda was the appropriate test statistic. Main effect results indicated no statistical significance [Wilks’Λ = .946, F(15, 1071) = 1.453, p > .01] and effect size was small (η² = .018). This can be interpreted to mean that High School Zone had no effect on responses for any of the five factor subscales.

**Program of study.** A one way MANOVA was conducted to determine if difference existed among the seven Program of Study categories in the mean survey response of the five factor scales. The categories were Agriculture, Business, Communication Arts, Culinary, Education, Engineering, and Medical. The assumption of homogeneity of variance-covariance was not met (Box’s M < .001); therefore, Pillai’s Trace was the appropriate test statistic (Mertler & Vanatta, 2008). Main effect results indicated statistical significance [Pillai’s Trace = .141, F(30, 1945) = 1.877, p < .01]. For this test, effect size was small (η² = .028). Given the significance of the overall test, the univariate main effects were examined. Results further supported a finding of significance [F(6,389) values ranged from 1.081 to 5.810, p < .01 in two cases]. Statistically significant univariate main effects were obtained for the Job Seeking Skills factor [F(6,389) = 3.655, p>.01] and the Economic Skills factor [F(6, 389) = 5.810, p < .01]. The effect sizes ranged from small (η² < .02) in those factors (3) with no significant differences to medium (η²>.05) in those factors (2) with significant differences. Table 15 summarizes the ANOVA main effect results.
Table 15

Univariate Main Effect Results for Program of Study Groups on Five Factor Scores

<table>
<thead>
<tr>
<th>Variable</th>
<th>df</th>
<th>ms^2</th>
<th>F</th>
<th>Sig</th>
<th>η^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job Seeking Skills</td>
<td>6</td>
<td>2.249</td>
<td>3.655</td>
<td>.002</td>
<td>.053</td>
</tr>
<tr>
<td>Error</td>
<td>389</td>
<td>.615</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication Skills</td>
<td>6</td>
<td>.419</td>
<td>1.081</td>
<td>.373</td>
<td>.016</td>
</tr>
<tr>
<td>Error</td>
<td>389</td>
<td>.388</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collaboration Skills</td>
<td>6</td>
<td>.382</td>
<td>1.159</td>
<td>.328</td>
<td>.018</td>
</tr>
<tr>
<td>Error</td>
<td>389</td>
<td>.330</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Problem Solving Skills</td>
<td>6</td>
<td>.696</td>
<td>2.013</td>
<td>.063</td>
<td>.030</td>
</tr>
<tr>
<td>Error</td>
<td>389</td>
<td>.346</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic Skills</td>
<td>6</td>
<td>5.502</td>
<td>5.810</td>
<td>.001</td>
<td>.082</td>
</tr>
<tr>
<td>Error</td>
<td>389</td>
<td>.947</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Univariate pairwise comparisons and post hoc Tukey analyses were conducted on the Factor 1: Job Seeking Skills factor. Results of the pairwise comparison revealed statistically significant differences between Program of Study categories for mean responses to Factor 1: Job Seeking Skills at a p < .05 level. Table 16 summarizes these differences for Factor 1: Job Seeking Skills. Those differences that were not statistically significant were removed.
Table 16

*Univariate Pairwise Comparison of Statistically Significant Differences Between Programs of Study for Factor 1: Job Seeking Skills*

<table>
<thead>
<tr>
<th>Program of Study (I)</th>
<th>Program of Study (J)</th>
<th>Mean Difference (I - J)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>Education</td>
<td>.480</td>
<td>.017</td>
</tr>
<tr>
<td>Business</td>
<td>CommArts</td>
<td>.371</td>
<td>.019</td>
</tr>
<tr>
<td></td>
<td>Education</td>
<td>.699</td>
<td>.001</td>
</tr>
<tr>
<td></td>
<td>Engineering</td>
<td>.336</td>
<td>.050</td>
</tr>
<tr>
<td>CommArts</td>
<td>Business</td>
<td>-.371</td>
<td>.019</td>
</tr>
<tr>
<td></td>
<td>Culinary</td>
<td>-.265</td>
<td>.046</td>
</tr>
<tr>
<td></td>
<td>Medical</td>
<td>-.311</td>
<td>.007</td>
</tr>
<tr>
<td>Culinary</td>
<td>CommArts</td>
<td>.265</td>
<td>.046</td>
</tr>
<tr>
<td></td>
<td>Education</td>
<td>.594</td>
<td>.002</td>
</tr>
<tr>
<td>Education</td>
<td>Agriculture</td>
<td>-.480</td>
<td>.017</td>
</tr>
<tr>
<td></td>
<td>Business</td>
<td>-.699</td>
<td>.001</td>
</tr>
<tr>
<td></td>
<td>Culinary</td>
<td>-.594</td>
<td>.002</td>
</tr>
<tr>
<td></td>
<td>Engineering</td>
<td>-.363</td>
<td>.046</td>
</tr>
<tr>
<td></td>
<td>Medical</td>
<td>-.640</td>
<td>.001</td>
</tr>
<tr>
<td>Engineering</td>
<td>Business</td>
<td>-.336</td>
<td>.050</td>
</tr>
<tr>
<td></td>
<td>Education</td>
<td>.363</td>
<td>.046</td>
</tr>
<tr>
<td></td>
<td>Medical</td>
<td>-.277</td>
<td>.039</td>
</tr>
<tr>
<td>Medical</td>
<td>CommArts</td>
<td>.311</td>
<td>.007</td>
</tr>
<tr>
<td></td>
<td>Education</td>
<td>.640</td>
<td>.001</td>
</tr>
<tr>
<td></td>
<td>Engineering</td>
<td>.277</td>
<td>.039</td>
</tr>
</tbody>
</table>

The analysis revealed statistically significant differences between the Education Program of Study and five of the other programs indicating that respondents from Education rated their acquired job seeking skills significantly lower than those who were studying Agriculture, Business, Culinary, Engineering and Medical. Similarly, Communication Arts respondents rated their acquired job seeking skills significantly lower than those studying Business, Culinary and Medical.
Conversely, respondents in the Medical program of study rated their acquired job seeking skills significantly higher than those who were studying Communication Arts, Education or Engineering. Respondents in the Business program rated their acquired job seeking skills significantly higher than those respondents studying Communication Arts, Education, and Engineering. Respondents studying Agriculture and Culinary rated themselves significantly higher in job seeking skills than did those studying Education, and Culinary respondents also rated themselves significantly higher than those studying Communication Arts. Engineering, respondents rated their acquired job seeking skills significantly higher than some programs of study, such as Education, and significantly lower than others, such as Business or Medical.

In the analysis of Tukey’s HSD, statistically significant differences existed for Factor 1: Job Seeking Skills. However, fewer significant mean differences were identified than in the univariate pairwise comparisons because Tukey’s test, which includes a correction for experiment-wise error due to the probability of Type I error increases when making multiple comparisons, is conservative when there are unequal sample sizes (Mertler & Vanatta, 2008). Respondents in the Education program of study ranked themselves significantly lower in acquired job seeking skills than those who studied Business or Medical. Though their mean scores were lower than each of the other areas of study, they were not statistically significant at the .01 level. The only other statistically significant differences evidenced by Tukey’s HSD were between Business and Education, as well as Medical and Education, in which Business and Medical students rated themselves higher in acquired job seeking skills than did the Education
students. Table 17 summarizes the statistically significant differences revealed by the Tukey HSD analysis.

Univariate pairwise comparisons and post hoc Tukey analysis were also conducted on the Factor 5: Economic Skills factor. Results of the pairwise comparison revealed statistically significant difference among Program of Study categories for mean responses to Factor 5: Economic Skills at a p < .05 level. Table 18 summarizes statistically significant differences for Factor 5: Economic Skills (those not found to be significant have been removed).

Table 17

Summary of Statistically Significant Mean Differences for Factor 5: Economic Skills Among Program of Study Groups by Mean & Standard Deviation

<table>
<thead>
<tr>
<th>Program of Study (I)</th>
<th>Program of Study (J)</th>
<th>Mean Difference (I - J)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>Education</td>
<td>1.117</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Business</td>
<td>CommArts</td>
<td>.426</td>
<td>.030</td>
</tr>
<tr>
<td></td>
<td>Education</td>
<td>1.297</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>CommArts</td>
<td>Business</td>
<td>-.426</td>
<td>.030</td>
</tr>
<tr>
<td></td>
<td>Education</td>
<td>.870</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Culinary</td>
<td>Education</td>
<td>1.185</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Education</td>
<td>Agriculture</td>
<td>-1.117</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Business</td>
<td>-1.297</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>CommArts</td>
<td>-.870</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Culinary</td>
<td>-1.185</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Engineering</td>
<td>-.927</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Medical</td>
<td>-1.001</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Engineering</td>
<td>Education</td>
<td>.927</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Medical</td>
<td>Education</td>
<td>1.001</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>
In the pairwise comparison, differences existed between respondents in the Education program and all other Program of Study respondents for this factor. Students studying Education rated themselves significantly lower than all of their peers in other programs of study with regard to acquired economic skills. Table 19 summarizes these differences. One other noted significance was that Business students rated themselves significantly higher in acquired economic skills than their peers studying Communication Arts.

In the analysis of Tukey’s HSD, similar statistically significant differences existed for Factor 5: Economic Skills. However, due to the conservative nature of the Tukey test, the significant difference between Business and Communication respondents found in the univariate pairwise comparison was no longer significant using the Tukey standard. Again, Tukey results showed that respondents in the Education program of study ranked themselves significantly lower in acquired economic skills than their peers in all other areas of study. Table 20 summarizes the differences revealed by the Tukey HSD analysis.

Summary

The purpose of this chapter was to present the data analysis results from the tests conducted on the survey tool to address research questions one through four. Question one was answered through factor analysis. Five empirical factors were identified from the survey instrument responses. These were found to be congruent with the original five categories established by the developers of the instrument, though the number of items showing significance was reduced from 55 to 31. Question two was answered using Cronbach’s alpha to determine reliability among all items, among items related to each
factor, and among factors. In all cases, the test for reliability ($\alpha > .70$) was met. Question three was answered using Pearson’s product moment correlation coefficient ($r$). A significant positive correlation was found among and between all five factors.

For question four, a series of one-way MANOVA tests was conducted for each of five groups defined by the demographics of Ethnicity, Gender, Socio-economic Status (SES), High School Zone, and Program of Study. When statistically significant differences occurred, a post hoc MANOVA analysis, as well as a Tukey’s HSD test, was conducted. No statistically significant differences occurred in the Ethnicity, Gender, SES or High School Zone demographic variables. Statistically significant differences were identified in the Program of Study demographic category. Chapter five will provide a summary and discussion of the results, draw conclusions based on the findings, and make recommendations for practical application and further research.
CHAPTER 5

The primary purpose of this study was to establish validity of a survey instrument used to gather information about perceptions of acquired levels of 21st Century skills (see definition on p. 13) mastery among high school students enrolled in Career & Technical Education (CTE) classes. A secondary purpose was to explore relationships among responses based on student membership in specific demographic groupings.

Quantitative data analysis using statistical testing procedures was utilized to investigate each research question. Factor analysis with appropriate rotation was used to determine empirical factors. Reliability analysis to establish internal consistency employed Cronbach’s alpha. Correlation analysis using Pearson’s r was used to establish relationships among factors. Multivariate analyses of variance (MANOVA) with appropriate post hoc tests were used to determine whether responses differed between groups. The final chapter presents a discussion of the key findings in light of current research, provides implication for practice, and provides recommendations for further research.

Research Question 1

Given the sample of the study, what are the empirical factors for the survey instrument? To what extent are the empirical factors congruent with the original factors established by the developers of the instrument?

This study examined an assessment tool used at a high school to measure student perceptions of 21st Century skills acquisition after completing a CTE course. Because the instrument was developed prior to the study and then modified for use at the school, no research for validity or reliability of the instrument had been conducted by the developing
agency or the school. To determine the degree to which the intended interpretation of the scores supported the intended purpose of the instrument, it was necessary to test the validity of the instrument (AERA et al., 1999). A test of internal structure reliability was used to provide evidence of test validity (Hogan & Agnello, 2004).

Using a principal component analysis, eight potential factors were initially identified. These eight were pared down using the generalized least squares factor analysis method with an orthogonal equamax rotation resulting in five interpretable factors. Of the 55 original items examined for a statistical relationship to the five identified factors, only 31 were found to significantly contribute to the intended purpose of the instrument. This suggested that 24 of the items included in the instrument made no significant contribution to the instrument’s intended purpose. These 24 items were removed for the remainder of the study.

Upon examination of the 31 items and the constructs, five factors were assigned names that reflected the dimensions of the associated survey items: Job Seeking Skills, Communication Skills, Collaboration Skills, Problem Solving and Reasoning Skills, and Economic Skills. These five factors were found to be essentially congruent with the original five categories established by the developers of the instrument. These results indicate that the instrument does have construct validity, supporting the hypothesis that the instrument is measuring a set of underlying constructs that are collectively called 21st Century skills.

**Research Question 2**

Given the empirical factors established in question 1, what are the reliabilities of the items that contribute to each factor?
The second research question of this study examined the reliability of the new empirical factors and their associated variables. Cronbach’s alpha was calculated on the five new factors and 31 retained items to determine if the individual survey items, survey items contributing to each factor, and identified factors of the test instrument were related to one another. For the 31 individual items, the alpha score (α > .70) indicated reliability. Alpha scores calculated for each factor, using only those survey items contributing to that factor, ranged from α = .798 to α = .953, indicating reliability for each factor. The overall alpha score calculated among all five factors, also indicated reliability at α = .835. In all cases, Cronbach’s alpha exceeded the accepted standard of reliability for social research, α > .70, indicating a significantly high level of internal consistency (Nunnaly, 1978).

These findings suggest that 31 items, as a whole, are measuring an overall similar construct or latent trait known as 21st Century skills. Further, the findings for Factor 1 indicated that the contributing items were all measuring a similar construct named Job Seeking Skills. These results were consistent for Factors 2, 3, 4, and 5, each measuring a specific construct under the heading of 21st Century skills. These results of the factor analysis and the reliability analyses suggest that the instrument meets the definition of validity based on a high degree of evidence that the assessment is measuring what it was intended to measure (Key, 1997; Standards for Educational and Psychological Testing, 1999).

Research Question 3

The third research question sought to determine whether relationships existed among the new factors identified in research question one. The results of a Pearson’s $r^2$
analysis indicated a statistically significant proportion of shared variance between factors, as measured on a -1.0 to 1.0 continuum. This indicated a direct, linear relationship such that an increase in one variable will correspond to an increase in the second. All factors showed a statistically significant positive correlation with the others. The strongest correlation was found between Communication Skills and Problem Solving Skills ($r = .683$). By calculating the coefficient of determination ($r^2$), the percent of variance can be explained as 46.6% of the change in one variable can be explained by the variation in the other variable. The majority of the Pearson’s $r$ scores were close to .50, indicating a moderately positive correlation (Taylor, 1990). The coefficient of determination for these relationships ranged from $r^2 = .219$ (21.9%) to $r^2 = .341$ (34.1%) of the variation explained. Though statistically significant at $r = .350$, the relationship between Collaboration Skills and Economic Skills can be considered weak (Taylor, 1990) and only accounts for 12.2% of the variance between factors ($r^2 = .122$).

**Research Question 4**

The final research question sought to determine if differences existed between demographic groups with regard to the perceptions of 21st Century skills acquisition using the 31 items and 5 factors as the new variables. Using a series of one-way multivariate analyses of variance (MANOVA) tests, groups were examined based on the demographic designation of Ethnicity, Gender, Socio-economic Status, High School Zone, and Program of Study. No significant differences were found for Ethnicity, Socio-economic Status or High School Zone. An overall cumulative significant difference was found for Gender, indicating that there is an overall difference between the perception of skills acquisition of girls and boys across all factors (Cook, 2010). However, no
significant differences were revealed in the univariate analyses indicating that the mean differences in responses for each factor were not significantly different between girls and boys. In the analysis of Program of Study, significant differences were also found in both the multivariate test and the univariate tests. In each of the factors, Job Seeking Skills and Economic Skills, Education ($n = 27$) students had a lower perception of skills acquisition than almost all other students in other programs of study (only Communication Arts students had a lower perception of skills acquisition in Job Seeking Skills).

**Key Findings**

This research revealed two key findings. The first major finding, based on the data from the factor analysis, indicated the potential for an improved instrument that is psychometrically sound. Removing the 24 test items that did not significantly contribute to the intended purpose of the survey will create a shorter version of the assessment; thus, reducing the time required for test administration. The second major finding indicated that the instrument may be a reliable tool for use with a wide variety of student populations. The MANOVA results revealed only limited differences based on demographic membership for Ethnicity, Gender, Socio-economic Status, High School Zone, and Program of Study. This suggests that the instrument could be used across a range of student populations with an expectation of similar results.

**Discussion**

The findings of this research provide the basis for a shorter, more easily administered and tabulated instrument to measure 21st Century skills acquisition. As well, based on the initial findings of this study, the improved instrument could provide a
reliable tool for application across a range of students in varying demographic groupings and varying educational settings. This has particular relevance within the context of readiness for college and career, as educational leaders search for ways to efficiently and effectively measure the non-cognitive 21st Century skills which are inextricably linked to postsecondary success in all settings.

A psychometrically sound measure that could be used with a high degree of confidence across populations could provide support to national initiatives aimed at closing the gap between high school and postsecondary expectation, such as the implementation of Common Core State Standards (CCSS) for K-12 education. While these standards purport to integrate 21st Century competencies with academic outcomes to better prepare high school graduates (CCSSI, 2011), the highly contextualized nature of these competencies presents a challenge for measuring growth independent of academic ability (P21, 2009; 2011). A short, user-friendly self-assessment administered periodically throughout high school could provide insight regarding student progress in blending a wide range of knowledge and skills in order to identify, analyze, and solve problems using communication, collaboration, and creativity. These are the skills essential to postsecondary success (American Diploma Project, 2004; Conley, 2007; Kay, 2010; P21, 2009; U.S. Department of Labor, 1992).

A reliable, easily administered measure of 21st Century skills attainment could also provide further empirical evidence that Career and Technical Education (CTE) successfully integrates specialized technical skills and 21st Century competencies with an outcome of preparing graduates for the demands of college, careers, and citizenship. This evidence would provide more support for Career and Technical Education as a highly
rigorous educational pathway that leads students directly to college (ACTE et. al., 2010). A sound instrument to measure 21st Century skills growth within the context of CTE could also provide evidence that would assist educational leaders in identifying best practices that are inherent to CTE methodology. These practices could then be examined for potential application in other educational domains as a means to improve student outcomes for postsecondary success.

**Improved efficiency in implementation.** A modification of the instrument to reduce the length to include only those 24 items found to contribute to the constructs would result in a shorter, more accurate instrument that could be easily administered, tabulated, and analyzed. This would reduce instruction time lost for test administration, as well as reduce the impact on technology resources needed for test administration. The removal of the 24 items that were not found to contribute to the identified factors would increase the interpretability of the results and reduce the potential for drawing incorrect conclusions.

As well, the ease of administering a modified instrument could provide a means of supporting attainment of critical 21st Century skills through frequent measurement coupled with design of targeted interventions to improve outcomes. As an example, if the instrument were utilized in a biannual test-retest format, or as an annual measure of growth throughout high school, the instrument might provide useful data regarding student progress toward college and career readiness. This practice could be particularly significant in conjunction with implementation of the CCSS. Data gathered from a short, efficient assessment could help educators to design comprehensive interventions and to monitor increases in 21st Century readiness.
Application across populations. Few differences were found among demographic groups with regard to perceptions of 21st Century skills acquisition, as measured by the five constructs. This suggests that students will have similar responses to the survey items regardless of gender, ethnicity, socio-economic status, program of study, or high school zone. These initial results indicate that the tool may have a broad application across a wide range of populations which include students from multiple backgrounds and in differing programs of study.

These findings suggest that the results of the instrument administered to a wide variety of high school students would yield demographically similar results. This would allow for further analysis and examination of other curricular factors independent of these demographics, such as type of curriculum, teaching style, or pedagogical practice. The results of this type analysis could provide insights that would allow educators to identify promising practices for generalization across disciplines in an effort to improve 21st Century skills acquisition. Such practices could increase both employability and college success (Olson, 2007; Conley, 2007).

Recommendations for Further Research

This quantitative study of an existing survey instrument, as well as the examination of differences in perceptions of groups of student based on demographic membership, has generated recommendations for future research. The findings presented in this study may be helpful to advance the search for an appropriate, efficient tool that would allow high schools to assess student acquisition of 21st Century skills. The data derived from this research indicates that the revision of the existing instrument into a new assessment tool using the 5 factors and 31 items identified is psychometrically sound.
Thus, follow up research could be conducted to provide data regarding the revised instrument’s stability over time, more insight into the instrument and potential use in a CTE context, and evidence of the potential for application to a broader audience.

Opportunities for further research using a revised instrument are discussed below.

1. **Non-significant item analysis.** The factor analysis conducted on the original 55 variables identified five empirical factors that were consistent with the five categories identified by the instrument developers. Through this analysis, only 31 of those variables were found to be statistically significant and contribute to the five identified factors. Further research should be conducted to determine whether the remaining 24 variables contribute to understanding measurement of 21st Century skills.

2. **Additional demographic studies.** This study considered five demographic categories of membership which may relate to student perceptions of 21st Century skills acquisition. While no significance was found in three of those categories, both Gender and Program of Study indicated significant differences in student perceptions. Further examination of each of those demographic groups, particularly given the unbalanced groups in this study, may provide insight. As well, further study using additional demographic variables such as grade point average, grade level, and standardized test scores may provide more information about 21st Century skills acquisition.

3. **Longitudinal study.** This study was conducted in a small, CTE-focused school that was unique. A more comprehensive examination could include a similar study at the same institution over time. By comparing similar data sets over
multiple years, a clearer picture of the stability of 21st Century skills acquisition over time could be drawn. As well, researchers could extend this study to include teacher perceptions of student acquisition of 21st Century skills. Comparison could be made between student and teacher perceptions.

4. **Replication on a larger scale.** Further study could utilize data from other institutions to replicate the study on a larger scale. Researchers could extend this study to include multiple CTE focused high schools so that broader conclusions could be drawn about the instrument. This would also provide an opportunity for comparisons between schools, as well as further analysis of different populations, which would lead to a deeper understanding of the perceptions of 21st Century skills acquisition.

5. **Examination of curriculum.** Given the above suggestions, if the new instrument proves to be stable over time and among broader groups of students, the instrument could be used to evaluate various curriculum pathways for evidence of teaching 21st Century skills. For example, results indicated significantly lower perceptions of 21st Century skills acquisition, particularly in the areas of Job Seeking Skills and Economic Skills for students studying Education. This suggests that it may be appropriate to examine the curriculum in this program of study with regard to how these skills are being taught, practiced, and assessed. This instrument, used in a test-retest situation, could help determine program effectiveness in this curriculum pathway, as well as others.
Summary

An examination of this survey instrument established a framework of five empirical factors that provide a valid measurement of student perceptions of 21st Century skills attainment with a specific sample population. The identified factors closely resembled the categories represented in the original instrument. These findings indicated that revising the original instrument to reflect only those items that contributed to the construct would yield an efficient, valid and reliable tool. Further, an examination of differences in demographic groupings revealed limited differences in perceptions of 21st Century skills. These findings indicated that the instrument may have a broad application among student populations. Finally, several recommendations for further research emerged that would expand the generalizability of findings and provide a more complete picture of 21st Century skills acquisition.
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Appendix A: UNR Institutional Review Board Approval
Appendix A

Institutional Review Board Approval Certification

Office of Human Research Protection
218 Ross Hall / 331, Reno, Nevada 89557
775.327.2368 / 775.327.2369 fax
www.unr.edu/ohrp

University of Nevada, Reno

Certification of Approval for New Protocol: Exempt Research
Exempt, No Committee (archive) Institutional Review Board
FWA00002306

Date: July 5, 2012
To: George C Hill, PhD Department of Educational Leadership
Copy:

UNR Protocol Number: 2013E002
Protocol Title: A Critical Analysis of an Instrument Used to Measure 21st Century Skills
Attainment Among High School CTE Students

Sponsor Names:

Meeting/Review Date: 07/05/2012
Type of Review: Exempt Minimal risk
Approval Period: July 5, 2012 to July 4, 2013

This approval is for:

Approved number of subjects: 450
Approved documents: Variable List (Protocol support docs (all)), 21st Century Skills Survey (MISC Complete Submission), ryan_Review_ExemptResearch_051512.Docx (REV Checklists)

The above-referenced protocol was reviewed and approved by one of UNR's Institutional Review Boards in accordance with the requirements of the Code of Federal Regulations on the Protection of Human Subjects (45 CFR 46 and 21 CFR 50 and 56).

PI Responsibilities

☐ Maintain an accurate and complete protocol file.
☐ Submit continuing projects for review and approval prior to the expiration date.
☐ Submit proposed changes for review and approval prior to initiation, except when necessary to eliminate apparent immediate hazards to subjects. Such exceptions must be reported to the IRB at once.
☐ Report any unanticipated problems which may increase risks to human subjects or unanticipated adverse events to the IRB within 5 days.
☐ Submit a closure request 10 days after project completion to the IRB.

Reference the protocol number on all related correspondence with the IRB. If you have any questions, please contact Nancy Moody at 775.327.2368.

For Veteran’s Administration research only
VA Research: No
Flag VA Medical Record: N/A
Appendix B: Local School District Institutional Review Board Approval
Appendix B

Letter of Permission from the Office of Accountability

Research Request Approval

July 9, 2012

Name of Proposed Study: A Critical Analysis of an Instrument Used to Measure 21st Century Skills Attainment Among High School CTE Students

Affiliation: UNR

Principal Investigators: Dana Ryan, George C. Hill

Please be advised that approval to conduct the requested research has been granted by the Department of Accountability, with these five conditions:

1. Participation by any student, any teacher, any administrator, or any school is voluntary.
2. Student, teacher, administrator, school, and district anonymity shall be assured in the research project. The identity of students, teachers, administrators, schools and the district shall not be revealed in any report of the study, except by prior written permission of this office.
3. The results of the study shall not be used for any purpose other than that specified in the research application, except by prior written permission of this office.
4. A copy of the report of the study shall be filed with this office and with the principal of any school that has participated in the study.
5. The study must conform to the federal Family Education Rights and Privacy Act (FERPA), all federal regulations dealing with Protection of Human Subjects and the Washoe County School District Board Policies pertaining to student information.

Approval to conduct this study within the Washoe County School District expires:

July 8, 2013
Appendix C: Copy of Original Survey Instrument
Appendix C

Copy of Survey Instrument Used for Research

1. Please type your first and last name.

2. Please rate how much you feel you have improved academically in the past school year at whatever school you attended.

<table>
<thead>
<tr>
<th>Academic Achievement</th>
<th>No Improvement</th>
<th>Stayed the Same</th>
<th>Some Improvement</th>
<th>Much Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

   Explain any unique circumstances in the past year that affected your achievement:

3. How do you prefer to learn?
   - In a whole class setting
   - In a small group
   - On a computer
   - In a lab setting (hands-on)
   - In a lecture
   - Another way I like to learn is:

4. How do you prefer to work?
   - Individually
   - In groups of 2
   - In groups of 4-5
   - Other (please specify)

5. How do you learn best? Choose two:
   - Listening in class
   - Viewing information provided in class
   - Watching demonstrations
   - Participating in discussions
   - Doing labs or hands-on activities
   - Other (please specify)
6. Is there anything you would like to add or change in our school?

7. What do you think would improve your learning?

These are some of the JOB SEEKING and CAREER DEVELOPMENT skills that are important for you to acquire by the time you graduate. We would like you to evaluate where you are in the process of learning these skills TODAY.

* 8. Please read each skill. For EACH skill, check ONE box that describes how you rate yourself TODAY in that skill.

<table>
<thead>
<tr>
<th>Skill</th>
<th>I have not been taught this yet</th>
<th>I know what this skill is but haven’t practiced it</th>
<th>I am working to develop and improve this skill</th>
<th>I can do this reasonably well</th>
<th>I am really good at this!</th>
</tr>
</thead>
<tbody>
<tr>
<td>I know about different sources of information.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I know my own abilities, interests, and aptitudes.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I know occupational characteristics.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can identify career/occupational goals.</td>
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<td></td>
</tr>
<tr>
<td>I can develop a career plan.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can identify and research potential employers.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I know employment positions I would like to hold.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can accurately complete an inquiry letter.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can accurately complete a resume.</td>
<td></td>
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<tr>
<td>I can accurately complete a follow-up letter.</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>I can accurately complete a job application.</td>
<td></td>
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</tr>
<tr>
<td>I can handle an interview without errors.</td>
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<td></td>
</tr>
<tr>
<td>I know how to find information about future education and training.</td>
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<td></td>
</tr>
</tbody>
</table>
These are some of the COMMUNICATION skills that are important for you to acquire by the time you graduate. We would like you to evaluate where you are in the process of learning these skills TODAY.

**9. Please read each skill. For EACH skill, check ONE box that describes how you rate yourself TODAY in that skill.**

<table>
<thead>
<tr>
<th>I have not been taught</th>
<th>I know what this skill is but haven't practiced it</th>
<th>I am working to develop and improve this skill</th>
<th>I can do this reasonably well</th>
<th>I am really good at this!</th>
</tr>
</thead>
<tbody>
<tr>
<td>I report accurately and concisely.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I follow the intent of oral directions or instructions.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I speak distinctly.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I ask questions.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I reword questions accurately.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I explain activities and ideas clearly.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I use appropriate vocabulary and grammar.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I give clear instruction and directions.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I stay on topic.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I use nonverbal communication appropriately.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I can develop oral presentations.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I can present information effectively to groups.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
These are some of the INTERPERSONAL skills that are important for you to acquire by the time you graduate. We would like you to evaluate where you are in the process of learning these skills TODAY.

**10. Please read each skill. For EACH skill, check ONE box that describes how you rate yourself TODAY in that skill.**

<table>
<thead>
<tr>
<th>Skill</th>
<th>I have not been taught</th>
<th>I know what this skill is but haven’t practiced it</th>
<th>I am working to develop and improve this skill</th>
<th>I can do this reasonably well</th>
<th>I am really good at this!</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can work cooperatively with my classmates.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I can work cooperatively on team activities.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I can work cooperatively with adults outside of school.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I exhibit openness and flexibility.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I seek clarification of instructions.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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</tr>
<tr>
<td>I exercise patience and tolerance.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I accept and use suggestions about to improve my skills.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I take initiative in getting work done.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I express my opinions with respect for others (factfully).</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I demonstrate the ability to negotiate differences with and among others.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
These are some of the PROBLEM SOLVING & REASONING skills that are important for you to acquire by the time you graduate. We would like you to evaluate where you are in the process of learning these skills TODAY.

**11. Please read each skill. For EACH skill, check ONE box that describes how you rate yourself TODAY in that skill.**

<table>
<thead>
<tr>
<th>Skill Description</th>
<th>Option 1: I have not been taught this yet</th>
<th>Option 2: I know what this skill is but haven't practiced it</th>
<th>Option 3: I am working to develop and improve this skill</th>
<th>Option 4: I can do this reasonably well</th>
<th>Option 5: I am really good at this!</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can recognize problems that need a solution.</td>
<td></td>
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<tr>
<td>I can identify procedures.</td>
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<tr>
<td>I know how to get resources.</td>
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<tr>
<td>I can prepare or set up material and equipment.</td>
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<tr>
<td>I can collect information.</td>
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</tr>
<tr>
<td>I can organize information.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>I can interpret information.</td>
<td></td>
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<tr>
<td>I can formulate alternative approaches.</td>
<td></td>
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</tr>
<tr>
<td>I can select efficient approaches.</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>I can review progress.</td>
<td></td>
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<tr>
<td>I can evaluate an activity.</td>
<td></td>
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<tr>
<td>I can correct errors.</td>
<td></td>
<td></td>
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<tr>
<td>I can make conclusions.</td>
<td></td>
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</tr>
<tr>
<td>I can summarize and communicate results.</td>
<td></td>
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</tbody>
</table>
These are some of the BUSINESS & ECONOMIC skills that are important for you to acquire by the time you graduate. These questions are specific about your Career/Technical Education CLASS or ACADEMY. We would like you to evaluate where you are in the process of learning these skills TODAY.

* 12. Please read each skill. For EACH skill, check ONE box that describes how you rate yourself TODAY in that skill.

In my Career/Tech field of study:

<table>
<thead>
<tr>
<th>Skill Description</th>
<th>I have not been taught</th>
<th>I know what this skill is but haven’t practiced it</th>
<th>I am working to develop and improve this skill</th>
<th>I can do this reasonably well</th>
<th>I am really good at this!</th>
</tr>
</thead>
<tbody>
<tr>
<td>I understand how businesses are organized.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>I understand the concept of business competition.</td>
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<td></td>
</tr>
<tr>
<td>I know about the processes of marketing.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>I know about the processes of production.</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I understand business costs.</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I understand factors affecting profits.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
13. What grade are you in:
- 9th
- 10th
- 11th
- 12th

14. What academy are you in? (If you are thinking about changing, mark the academy you are in TODAY.)
- Biotechnology, Natural Resources & Veterinary Medicine
- Business & Finance
- Communication Arts & Media
- Culinary & Hospitality
- Early Childhood & Elementary Education
- Engineering & Renewable Energy
- Medical Careers

15. If you could, would you change to another academy?
- No
- Yes

Why?
16. Which academy would you switch to?

- Biotechnology, Natural Resources & Veterinary Medicine
- Business & Finance
- Communication, Arts & Media
- Culinary & Hospitality
- Early Childhood & Elementary Education
- Engineering & Renewable Energy
- Medical Careers

Why?

17. How long have you attended AACT?

- This is my first full year at AACT
- This is my second full year at AACT
- I started at AACT year (January, 2009 or 2010).

18. What do you plan to do after graduation? (choose one only)

- Four-year University
- Community College
- Certification program or Apprenticeship
- Trade School
- Travel Abroad
- Find a Job
- Other (please specify)
**19. What CTE class are you taking now?**

- Business and Finance (F)
- Digital Video (D)
- Health Occupations (G)
- Medical Assisting (C)
- Emergency Medical (E)
- Welding (R)
- CADD (A)
- Veterinary Medicine (C)
- Horticulture (G)
- Project Ready (R)
- Early Childhood Education (H)
- Graphic Arts (R)
- 3-D Design (S)
- Advanced Baking (W)
- Advanced Culinary (W)

**20. How long have you attended AAC?**

- This is my first year.
- This is my second year.
- This is my third year.
21. What class(es) did you take in previous years?

22. Which is your home high school?

- Coral Academy
- Damonte Ranch
- Galena
- Hug
- ICDA
- Incline
- McQueen
- Nevada Connections Academy
- North Valleys
- Reed
- Reno
- Sparks
- Spanish Springs
- TMCC High
- Washoe
- Wooster
- Other (please specify)
23. What do you plan to do after graduation? (choose one only)

☐ Four-year University
☐ Community College
☐ Certification program or Apprenticeship
☐ Trade School
☐ Travel Abroad
☐ Find a Job

Other (please specify) or Comments

Thank you for completing this survey. Your information will help us provide you with the best experience possible at the
Appendix D: Items in Five Categories of Original Survey Instrument
Appendix D

Items Included in the Five Categories of the Original Instrument

<table>
<thead>
<tr>
<th>Factor</th>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Job Seeking &amp; Career Development Skills</strong></td>
<td>I know about different sources of information.</td>
</tr>
<tr>
<td></td>
<td>I know my own abilities.</td>
</tr>
<tr>
<td></td>
<td>I know occupational characteristics.</td>
</tr>
<tr>
<td></td>
<td>I can identify career/occupational goals.</td>
</tr>
<tr>
<td></td>
<td>I can develop a career plan.</td>
</tr>
<tr>
<td></td>
<td>I can identify &amp; research potential employers.</td>
</tr>
<tr>
<td></td>
<td>I know employment positions I would like to hold.</td>
</tr>
<tr>
<td></td>
<td>I can accurately complete an inquiry letter.</td>
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<tr>
<td></td>
<td>I can accurately complete a resume.</td>
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<td></td>
<td>I can accurately complete a follow-up letter.</td>
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<tr>
<td></td>
<td>I can accurately complete a job application.</td>
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<tr>
<td></td>
<td>I can handle an interview without errors.</td>
</tr>
<tr>
<td></td>
<td>I know how to find information about future education and training.</td>
</tr>
<tr>
<td><strong>Communication Skills</strong></td>
<td>I report accurately and concisely.</td>
</tr>
<tr>
<td></td>
<td>I follow the intent of oral directions or instructions.</td>
</tr>
<tr>
<td></td>
<td>I speak distinctly.</td>
</tr>
<tr>
<td></td>
<td>I ask questions.</td>
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<tr>
<td></td>
<td>I answer questions accurately.</td>
</tr>
<tr>
<td></td>
<td>I explain activities &amp; ideas clearly.</td>
</tr>
<tr>
<td></td>
<td>I use appropriate vocabulary &amp; grammar.</td>
</tr>
<tr>
<td></td>
<td>I give clear instructions &amp; directions.</td>
</tr>
<tr>
<td></td>
<td>I stay on topic.</td>
</tr>
<tr>
<td></td>
<td>I use nonverbal communication appropriately.</td>
</tr>
<tr>
<td></td>
<td>I can develop oral presentations.</td>
</tr>
<tr>
<td></td>
<td>I can present information effectively to groups.</td>
</tr>
<tr>
<td><strong>Interpersonal Skills</strong></td>
<td>I can work cooperatively with my classmates.</td>
</tr>
<tr>
<td></td>
<td>I can work cooperatively on team activities.</td>
</tr>
<tr>
<td></td>
<td>I can work cooperatively with adults outside of school.</td>
</tr>
<tr>
<td></td>
<td>I exhibit openness and flexibility.</td>
</tr>
<tr>
<td></td>
<td>I seek clarification of instructions.</td>
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<tr>
<td></td>
<td>I exercise patience &amp; tolerance.</td>
</tr>
<tr>
<td></td>
<td>I accept and use suggestions to improve my skills.</td>
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<tr>
<td></td>
<td>I take initiative in getting work done.</td>
</tr>
<tr>
<td></td>
<td>I express my opinions with respect for others.</td>
</tr>
<tr>
<td></td>
<td>I demonstrate the ability to negotiate differences with</td>
</tr>
</tbody>
</table>
and among others.

<table>
<thead>
<tr>
<th>Problem Solving &amp; Reasoning Skills</th>
<th>Business &amp; Economic Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can recognize problems that need a solution.</td>
<td>I understand how businesses are organized.</td>
</tr>
<tr>
<td>I can identify procedures.</td>
<td>I understand the concept of business competition.</td>
</tr>
<tr>
<td>I know how to get resources.</td>
<td>I know about the processes of marketing.</td>
</tr>
<tr>
<td>I can prepare or set up materials &amp; equipment.</td>
<td>I know about the processes of production.</td>
</tr>
<tr>
<td>I can collect information.</td>
<td>I understand business costs.</td>
</tr>
<tr>
<td>I can organize information.</td>
<td>I understand factors affecting profit.</td>
</tr>
<tr>
<td>I can interpret information.</td>
<td></td>
</tr>
</tbody>
</table>
Appendix E: Items Retained After Factor Analysis
Appendix E

Items Removed from the Five Categories of the Original Instrument

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<tr>
<td></td>
<td>I demonstrate the ability to negotiate differences with and among others.</td>
</tr>
<tr>
<td><strong>Problem Solving &amp; Reasoning Skills</strong></td>
<td>I can recognize problems that need a solution.</td>
</tr>
<tr>
<td></td>
<td>I can correct errors.</td>
</tr>
<tr>
<td></td>
<td>I can make conclusions.</td>
</tr>
<tr>
<td></td>
<td>I can summarize and communicate results</td>
</tr>
<tr>
<td><strong>Business &amp; Economic Skills</strong></td>
<td></td>
</tr>
</tbody>
</table>