Clothing and Textiles: Reinforcing STEM Education through Family and Consumer Sciences Curriculum

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Advances in science and engineering are essential for ensuring America's economic growth and national security, according to the Alliance for Science and Technology Research in America (2010). Family and Consumer Sciences (FCS) programs can respond to this demand through the identification of parallels between science, technology, engineering, and math (STEM) education and clothing and textiles curriculum. FCS can help prepare young people for science and engineering careers related to the design, production, distribution, use, and disposal of clothing and textile. The purpose of this paper is to illustrate the opportunities for FCS teachers to strengthen student comprehension of STEM concepts utilizing clothing and textiles-related curriculum and/or courses. A teaching strategy for reinforcing STEM concepts and the integration of FCCLA to address this need is presented.

The U.S. Bureau of Labor Statistics (2010) stated that 16 of the 30 fastest-growing occupations projected through 2016 would require substantial mathematics or science preparation. But the country's high school students are not performing well in math or science, and fewer of them are pursuing degrees in technical fields. Even though greater emphasis is being placed on STEM fields, more work needs to be done to reinforce these concepts across disciplines (Association for Career and Technical Education, 2009). The instructional approach used by Career and Technical Education (CTE) programs can strengthen students understanding of STEM content and increase interest in STEM career pathways (ACTE, 2009). Not only are course offerings a concern of stakeholders and policy makers, the engagement of students in relevant learning experiences also impacts educational reform decisions. According to Yazzie-Mintz (2010), 49 percent of high school students are bored with school every day, and 17% with every class they take. To remain engaging and competitive in the global economy, the U.S. Department of Education (2010) recommends that our nation raise our expectations in order to ensure that every student graduates from high school well prepared for college and a career. Family and consumer sciences courses reinforce science, technology, engineering, and math (STEM) principles while engaging students in hands-on and relevant learning activities. Pathways associated with FCS and clothing and textiles content correspond to postsecondary education, college, and a wide variety of career opportunities. Specifically, the clothing and textile industry employs individuals in a variety of fields including design, manufacturing, distribution, marketing, retailing, advertising, communications, publishing, and consulting. Even though STEM professions might not require skills associated with clothing construction on a daily basis, having a course that develops future employees' comprehension of a process and piece of the clothing industry would be beneficial.

Careers of the 21st Century require high school graduates and future professionals who can use higher-order thinking skills (analysis, synthesis, and evaluation of concepts), problem solve, and work effectively in a team. Each of these skills are integrated into the curriculum completed by students enrolled in a clothing and textiles-related course in a junior high or high school setting. FCS teachers integrate research-based teaching strategies, such as inquiry-based instruction, to challenge students to innovate, develop, and complete useable products showcasing clothing and textiles content and higher-order thinking skills. Family, Career, and Community Leaders of America (FCCLA) assists teachers in maintaining student interest while connecting to real world issues and career preparation. To assess student outcomes in clothing and textiles and FCCLA, rubrics are used along with performance-based assessments to document a student's use of knowledge, skills, and abilities necessary for the workplace and life. This paper seeks to develop a rationale for secondary clothing and textiles curriculum, identify correlations between FCS national standards and key STEM principles, illustrate the use of a research-based teaching strategy to reinforce STEM concepts in the FCS classroom, and identify an FCCLA STAR Event that strengthens the connections between FCS and STEM. Overall, family and consumer sciences secondary courses bolster the current offerings in science, technology, engineering, and math by using real world and relevant examples such as clothing.

A Rationale for Clothing and Textiles Curriculum

The perennial issue of clothing design, production, manufacture, use, and disposal requires the integration of key STEM principles and educational frameworks. For example, the National Research Council (2012) developed a new vision for K-12 education in the sciences and engineering designed to actively engage students in scientific and engineering practices while applying crosscutting concepts to deepen their understanding of core concepts. In science, engineering and FCS, learning experiences provide students with fundamental questions about the world (National Research Council, 2012). Clothing and textiles curriculum outlined by the competency-based, conceptual and process perspectives of the *National Standards for Family and Consumer Sciences* (National Association of State Administrators of Family and Consumer Sciences, 2008-2018) identifies academic knowledge and a framework for posing fundamental questions about the world. In order to identify possible solutions to real world issues across disciplines, students must carry out scientific investigations and engineering design projects related to disciplinary core ideas (NRC, 2012).

Clothing and textiles is relevant as a field of study because each day individuals and families dress their bodies. Further, clothing production around the world fulfills a basic human need. Specific scientific and engineering practices required in the development of clothing for consumers includes asking questions (for science) and defining problems (for engineering); developing and using models; planning and carrying out investigations; analyzing and interpreting data; using mathematics and computational thinking; constructing explanations (for science), designing solutions (for engineering); engaging in argument from evidence, and obtaining, evaluating, and communicating information (NRC, 2012). In addition, the sociocultural and personal expression of an individual's identity is communicated directly through clothing. Students can analyze the function of specific garments based on performance characteristics, personal needs and

wants, and develop a justification or argument related to what they should or should not wear. Not only is it an important task each day, but clothing can also impact social interactions. There are many reasons why individuals dress themselves—for personal satisfaction, to communicate individual identity, for protection, or to advance the abilities of the body (Eicher, Evenson & Lutz, 2008).

Secondary clothing and textiles-related courses offer middle and high school students the opportunity to explore clothing as it expresses their basic needs and values. Potentially, these courses could facilitate the investigation of clothing construction practices of individuals living in various cultures outside and within the United States. Clothing can communicate individuality and an individual's position within various social systems: family, economy, religion, and community to name a few. Due to the increased interdependence of our world there is a great need for youth to be aware of and appreciate cultures other than our own.

The learning outcomes of clothing courses around the nation, and in Utah specifically, require students to apply STEM concepts through a variety of hands-on, laboratory-based learning experiences. The skills associated with clothing construction courses are transferrable to other careers in the textile industry that would be considered STEM-related careers (i.e., Product Development Engineer, Webmaster, Transportation Logistics Specialist, Network Analyst, etc.). The National Standards for Family and Consumer Sciences (NASAFACS, 2008-2018) that guide the development of secondary curriculum related to textiles, fashion, and apparel focus on students mastering the comprehensive task of "integrating knowledge, skills, and practices required for careers in textiles and apparel." For example, the textile industry manufactures materials used by a variety of companies that meet the basic human needs such as food and shelter. Fabrics and construction techniques are used in the food industry to provide plant covers, absorbent liners in prepackaged meats, and reusable cloth bags (Cohen and Johnson, 2010). In relation to shelter, fabric and construction techniques are used to create tents, building materials (insulation made from recycled denim blue jeans), and awnings. Cohen and Johnson (2010) asserted that textiles are found in every aspect of our lives, from the carpet we walk on and the bandages covering our injuries, to a factory conveyer belt and the space vehicles orbiting the earth.

As an industry, apparel construction and textile development companies have contributed significantly to the initial growth of the United States (Cohen and Johnson, 2010). The first craft to be mechanized using technology and engineering practices was the textile industry. Specifically, cotton was the first interstate commerce transporting the fiber cultivated in the South to the factories in the New England area (Cohen and Johnson, 2010). A majority of the 100,000 dollars earned by the 106 companies in the manufacturing industry in 1832 was provided by 88 textile companies. The textile industry is seen as a key contributor to the growth of not only the United States economy, but also when the devastating earthquake struck Haiti in 2010. Textiles were seen as the industry that would assist in the recovery of that economy. The United States Agency for International Development (2010) assisted the Haitian Government in developing the Haiti Apparel Center (HAC) to help in the continued development and expansion of Haiti's garment industry. The textile industry in Haiti produces about 75% of the country's exports in the form of clothing and before the earthquake, more than 25,000 Haitians worked in the apparel industry. This new center (HAC) seeks to provide

Haitians with the skills needed to work in the garment industry with the ultimate goal of assisting them to earn a better wage. The skills and knowledge associated with clothing and textiles have proven to be relevant with a huge impact on the quality of life for individuals and families in the United States and from around the world.

Since the apparel and textile industries can be seen as a boost to local, national, and international markets, there is great need for youth to be aware of the practices associated with the production of their clothing. Asking the questions, "Where does my clothing come from; how is it made?" are essential for the education of wise consumers of the future and professionals who are motivated to develop new products. While exploring the process of clothing construction in an introductory or advanced clothing and textiles middle or high school course students are challenged to think critically about their personal clothing purchasing habits. When students master the National Standard for Family and Consumer Sciences content standard 16.4 (NASAFACS, 2008-2018) "demonstrate skills needed to produce, alter, or repair fashion, apparel, and textile products" they are able to transfer these skills to the identification of garments that are constructed meeting high quality industry standards. For example, when a student is required to insert a zipper into a garment, they see firsthand what a correctly constructed zipper looks like. This hands-on experience can be useful when they inspect a zipper in a future clothing purchase of a pair of pants, a dress, or a jacket.

Students are not only challenged to demonstrate a new skill, but also the learning experiences associated with clothing and textiles courses can integrate the National Standard for FCS (NASAFACS, 2008-2018), reasoning for action. Specifically, students "demonstrate scientific inquiry and reasoning to gain factual knowledge and test theories on which to base judgments for action." Reasoning for action can be integrated into learning experiences when an FCS teacher utilizes teaching strategies such as inquiry-based instruction. The following discussion will correlate the family and consumer sciences national standards for textiles, apparel, and fashion with STEM concepts while providing information on strategies for using inquiry-based instruction.

Science, Technology, Engineering, and Math (STEM) Standards and FCS

Clothing and textiles curriculum for FCS students in high school reinforces standards for science, technology, engineering, and math required for graduation. To illustrate this point, the following discussion outlines the steps associated with the design, production, distribution and disposal of a clothing item first developed in the United States and now iconic worldwide: the denim jean.

Cotton and fabric production. The production of cotton, one of the world's most widely produced fibers, is the first stage in the manufacturing of blue jeans. According to Johnson and Cohen (2011), about 24 ounces of cotton fiber is used to produce one pair of jeans. Exploring the process of manufacturing cotton fabric to produce apparel, home, or industrial products requires students to analyze concepts related to physical, life, and engineering application of science. In an FCS course, students are challenged to evaluate fiber and textile products and materials (NASAFACS, 2008-2018). To accomplish this task, students use science process and thinking skills. Specifically, the goal of the science curriculum is to provide secondary students with the opportunity to develop an appreciation for science and to "use science as a process of obtaining knowledge based upon observable evidence" (Utah State Office of Education,

2003). In a laboratory setting, students are given samples of natural and synthetic fibers to identify, compare, and analyze the observable performance characteristics or traits of each fiber and/or fabric. Throughout the laboratory experience, students record both qualitative and quantitative information about each fiber or fabric (USOE, 2003). This information can be used in order to draw conclusions about which fibers are best for specific end uses, such as jeans. The physical and chemical properties of fibers can be further identified through a burn test administered by an FCS teacher.

The process of producing cotton can have adverse impacts on the environment. Specifically, cotton production can involve the use of pesticides and insecticides that can be a serious hazard to the health of farmers and consumers (Mancini & Mancini, 2009). Cotton farmers, producers, and manufacturers are working together to develop new technology and innovations to minimize the negative effects on farmers, factory workers, and other employees involved in this stage of the lifecycle of jeans and other cotton fiber clothing and/or materials. The application of STEM concepts is needed to address this environmental concern and provide a foundation for the development of new practices. In FCS courses students evaluate the elements of the textile, apparel, and fashion merchandising industry (NASAFACS, 2008-2018). According to the National Standards for FCS (NASAFACS, 2008-2018) students should be able to summarize textile legislation, standards, and labeling in the global economy and consider the effects of textile characteristics on the design, construction, care, use, and maintenance of products. Similarly, in technology and engineering education, students are challenged to demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology (International Society for Technology in Education, 2007). The integration of FCS and Technology and Engineering Education (TEE) concepts allows for students to use a real world issue as the context for innovation and creative or critical thinking. Further, TEE standards require students to develop an understanding of the effects of technology on the environment (International Technology Education Association, 2007).

Garment manufacturing. This stage involves the cutting, sewing, and finishing of the final product to be sold on an international market. FCS programs offer courses related to clothing construction at various levels for secondary students. The National Standards for FCS outline that students should be able to demonstrate the skills needed to produce, alter, or repair fashion, apparel, and textile products (NASAFACS, 2008-2018). To produce a textile product, such as the denim jean, it is necessary for students to use technology concepts, systems and operations (ISTE, 2007). The sewing machine, serger, and other computer-aided systems are used on a regular basis in the clothing and textile laboratory in a secondary school. Jeans are constructed using basic geometric shapes and angles, and also, the development of the sewing pattern requires the application of specific geometry standards. These concepts reinforce the requirement that students who complete a high school geometry course in Utah be able to "perform basic geometric constructions, describing and justifying the procedures used" (Utah State Office of Education, 2007). A performance indicator included in this standard requires students to "construct perpendicular and parallel lines and to copy and bisect angles and segments" (USOE, 2007). Each of these expectations can be accomplished through the completion of student projects in an FCS clothing and textiles classroom.

Clothing is constructed to fit the 3-D form of the human body. The measurements of the consumer or client who will be purchasing or wearing the final product, in this case denim jeans, need to be taken into consideration. High school geometry curriculum requires students to use "algebraic, spatial, and logical reasoning to solve measurement problems" (USOE, 2007). A garment cannot be constructed without utilizing geometric concepts and competencies. Students must refer to the pattern size appropriate for their body in order to purchase the correct amount of fabric to correlate with the body and pattern measurements being used to complete the project. Further, the Common Core State Standards Initiative (2010) challenges teachers across the nation to focus on eight core mathematical principles. FCS teachers reinforce five of these principles while facilitating student learning in clothing and textiles sewing laboratories. The specific mathematical principles met in FCS clothing and textiles curriculum are for students to be able to:

1) Make sense of problems and persevere in solving them,
2) Reason abstractly and quantitatively,
5) Use appropriate tools strategically,
6) Attend to precision, and
7) Look for and make use of structure (National Governors Association Center for Best Practices, & Council of Chief State School Officers, 2010).

Transportation and distribution. The textile industry employs individuals in a variety of career paths in order to successfully distribute clothing and textile products to consumers around the world. FCS standards state that students should be able to analyze career paths within textile, apparel, and design industries upon completion of courses in this content area (NASAFACS, 2008-2018). Clothing and textile companies transport and distribute their finished products to retail, online, and wholesale locations across the globe. This system requires the use of effective communication and collaboration and the use of technology operations and concepts to ensure on-time and accurate delivery. TEE challenges students to demonstrate, through the use of technology systems, mastery of technology operations and concepts. Correlation between FCS and TEE concepts is evident in this stage of the lifecycle of denim blue jeans. Not only is technology used in the transport and distribution of products, but clothing companies are also tracking the environmental impacts of various products from design through delivery. Programs such as GIS (Geographic Information Systems) can be used to provide basic product information to the consumer. Specific metrics calculated or documented during the production of denim jeans or other products include: energy consumption, CO_2 emissions, waste generation, and water use (Patagonia, 2009). These calculations can allow for students to apply math and science concepts as well as TEE required learning experiences.

Consumer use. The methods that consumers use to care for various clothing products, including blue jeans, can result in the greatest impact clothing has on the environment. According to Levi Strauss (2010), consumers can reduce the negative environmental impacts of their jeans by up to 50% by line drying and washing them in cold water. Family and consumer sciences (FCS) curriculum requires that students are able to apply appropriate procedures for the care of textile products (NASAFACS, 2008-2018). To meet this standard, secondary students need to be able to analyze chemicals in

society and how use of various products for the laundering of clothing impact the fibers in specific garments. Also, when considering the removal of various stains that can occur, students need to be able describe and explain chemical reactions. Are there chemicals that should not be mixed when laundering clothing? By combining certain products, can a better result be achieved? Both of these tasks are associated with required science standards for secondary students. Overall, clothing is a necessary basic human need in our society. The integration of clothing care and use information can assist consumers in making informed decisions about what clothing to purchase and how to maintain the quality of their purchase.

Garment recycling. The population of the United States discards around 11.9 million tons of clothing and textiles per year (USEPA, 2008). Clothing and textile companies are developing strategies for consumers to recycle their unwanted or gently used clothing products. When students are participating in a clothing and textiles course offered through FCS, they can be challenged to "generate design that takes into consideration ecological, environmental, sociological, psychological, technical, and economic trends and issues (NASAFACS, 2008-2018). Students can apply the elements and principles of design to recreate clothing and textile materials into new products or innovations. Similarly, TEE programs challenge students to be innovative and create new products or designs while considering the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving (ITEA, 2007). FCS students not only use the processes required in TEE education, but math concepts and techniques are also necessary. Clothing designs bring shapes and measurements to life. By repurposing clothing, students are taking a shape or form of clothing and rearranging the shapes to result in the same measurements of the wearer.

As evidenced by an everyday product like the denim blue jean, students can be exposed to important concepts and learning experiences in science, technology, engineering, and math within the clothing and textiles laboratory facilitated by an FCS teacher. Clothing and textiles curriculum also provides students with relevant and real world connections to the standards and competencies that are not only required for high school graduation, but can also help them be successful in STEM fields later on.

A Research-based Strategy for Teaching STEM Concepts through Clothing and Textiles

The approach used by teachers to develop curriculum and provide instruction in the FCS classroom is key to engaging students in the development of solutions to real world issues in our society. Life does not stop at the doorstep of the FCS classroom, but students are given the opportunity to explore creative and plausible solutions to everyday issues impacting the quality of life of individuals, families, and communities. There are a variety of real world issues that can be addressed. Each stage involved in the production of clothing can integrate the exploration of a relevant issue to youth today. When designing and implementing FCS clothing and textiles curriculum to reinforce STEM concepts, there are a variety of research-based teaching strategies that can be used. One specific strategy is inquiry-based instruction.

Inquiry-based instruction, a research-based teaching strategy, incorporates both inductive and deductive reasoning while students are actively engaged in identifying solution(s) to a problem or situation. Clothing and textiles-related courses provide

secondary students with multiple topics and situations that require them to think critically about how they would approach the situation. This teaching strategy focuses on the process of investigating the problem rather than on the correct solution (Moore, 2010). The following discussion will outline the integration of inquiry into a clothing and textiles-related lesson plan.

Phase one. Upon completion of the learning experience, students will be able to apply appropriate procedures for care of textile products (NASAFACS, 2008-2018). The first step in the inquiry process confronts students with a problem or issue. The teacher provides students with information about inquiry procedures and introduces the discrepant event, situation, or issue (Suchman, 1962). During the first few minutes of class, students are introduced to the issue of caring for textile products. The most difficult stains to remove (antiperspirant, ball-point ink, butter/cooking oils, catsup/pasta sauce, collar/cuff rings, dirt/mud, dirty socks, fruit juice, grass, motor oil, mustard, and perspiration) will be presented on white t-shirts for the students to remove. Once students develop an awareness of the issue, the second step of inquiry can be completed.

Phase two. Verification of the nature of the situation through the gathering of data is the next phase for students to complete. While in groups, students will focus on different stains to remove. To verify the nature of the situation, students will have to identify the fabric type, type of stain, and any other characteristics of the stain that can aid in removal. Specific engineering and scientific practices that students will use in this phase of inquiry are asking questions (science) and defining the specific characteristics of the problem (engineering), planning and carrying out the investigation, and analyzing and interpreting the data collected.

Phase three. Next, students experiment with the data to begin the process of hypothesizing and testing solutions to the situation. For phase three, students will carry out the experiment testing various stain removal techniques and solutions. This experiment will require multiple samples of the stained garment in order for students to identify the best solution and develop a justification based on the evidence. Throughout this step, students apply appropriate procedures for the care of textile products (NASAFACS, 2008-2018).

Phase four. Before the lesson is complete, students must organize, formulate, and provide an explanation of rules created to guide their personal solution to the issue. Are there specific stain removal procedures that are best for different fibers and/or stains? Is there a chart, graph, or table that can be created to help students organize the data? The process of graphing or charting findings correlates to science and engineering education.

Phase five. To conclude the lesson, students would evaluate the use of the inquiry process in this situation in order to refine the process for future events, situations, or issues. The identification of other applications of inquiry can be useful for students to comprehend the real world connections and applications of this strategy for addressing a discrepant event, situation, or issue. Multiple applications of this research-based teaching strategy in the family and consumer sciences classroom exist. Whether students are researching a common everyday issue or a complex situation with a variety of factors, this technique can prepare students to think critically about life situations.

Integration of FCCLA into Curriculum

Family, Career, and Community Leaders of America provides secondary teachers with curriculum resources that can strengthen student comprehension of STEM concepts. Across the nation, some FCS teachers are expected to integrate FCCLA into curriculum and/or the FCS program. Whether FCS teachers integrate a STAR Event or an FCCLA National Program into a course, the learning experience transforms students' knowledge of content, skills, abilities, and leadership capacity. Teachers can integrate a variety of STAR Events to address STEM concepts. For example, the Recycle and Redesign STAR Event requires students to select a used fashion, home, or other post consumer item to recycle into a new product (FCCLA, 2011-2012). The new product is assessed based on the student's effectiveness of product design, overall quality of workmanship, creativity, imagination, and innovation, and other skill-based techniques (FCCLA, 2011-2012).

The Recycle and Redesign assessment begins in the final stage of the life cycle of a garment, garment recycling. Since the life of a recycled garment extends the use of the original product, students participating in the event would need to refer to the beginning of the cycle to inform the development of their new product. For example, the assessment requires students to incorporate a material or fabric profile in the final display of their work. The fiber content and type, construction, finishes, properties, performance, and care of the original fibers used should be documented. This process relates to the first stage in the life cycle of a garment, cotton and fabric production. In addition to the correlations between STEM concepts and FCS previously outlined in the article, TEE standards addressed through this assessment focus on a student's ability to develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving (ITEA, 2007). Further, through the Recycle and Redesign STAR Event, students are able to select and use manufacturing technologies such as the sewing machine (ITEA, 2007).

Conclusions

Employers demand a workforce that is skilled in STEM-related concepts in order to compete in the global, fast-paced economy. Family and consumer sciences clothing and textiles related courses have a unique opportunity to reinforce STEM concepts in a rigorous and relevant way. Specifically, FCS clothing and textiles curriculum provides secondary students with laboratory-based experiences that will strengthen their comprehension of concepts and standards outlined in science, technology, engineering, and math education. Through continued development of the connections between family and consumer sciences, FCCLA, and STEM concepts, educators will see an increase in student motivation and preparation for STEM-related careers.

References

Alliance for Science & Technology Research in America. (2010). *K-12 STEM Ed report card.* Washington, DC: The Alliance for Science & Technology Research in America.

Association of Career and Technical Education. (2009). *Issue brief: CTE's role in science, technology, engineering, and math.* Alexandria, VA: The Association for Career and Technical Education.

Cohen, A.C., & Johnson, I. (2010). *J.J. Pizzuto's fabric science.* New York: Fairchild Books.

Eicher, J.B., Evenson, S.L, & Lutz, H.A. (2008). *The visible self.* New York: Fairchild Books.

Family, Career, and Community Leaders of America, Inc. (2011). *2011-2012 Competitive events guide.* Retrieved September 15, 2011 from http://www.fcclainc.org/content/competitive-events/.

International Society for Technology in Education. (2007). *NETS for students 2007.* Retrieved May 15, 2011 from http://www.iste.org/standards/nets-for-students/nets-student-standards-2007.aspx.

International Technology Education Association. (2007). *Standards for technological literacy: Content for the study of technology 3rd Edition.* Retrieved January 13, 2012 from http://www.iteea.org/TAA/Publications/TAA_Publications.html.

Levi Strauss & Co. (2010). *Life cycle of a jean.* Retrieved September 15, 2011 from http://www.levistrauss.com/sustainability/product/life-cycle-jean.

Mancini, C., & Mancini, F. (2009). *Less pesticide, more income from cotton.* Retrieved May 15, 2011 from http://www.naturalfibres2009.org/en/stories/cotton.html.

Moore, K. D. (2010). *Effective instructional strategies: From theory to practice.* Thousand Oaks, CA: Sage.

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: The National Academies Press.

National Association of State Administrators of Family and Consumer Sciences. (2008-2018). *National standards for family and consumer sciences.* Retrieved September 15, 2011 from http://www.doe.in.gov/sites/NASAFACS/index.html.

National Governors Association Center for Best Practices, & Council of Chief State School Officers. (2010). *Common core state standards: Mathematics.* Washington, DC: National Governors Association Center for Best Practices, Council of Chief State School Officers.

Patagonia. (2009). *Methodology for environmental cost calculations.* Retrieved September 15, 2011 from http://www.patagonia.com/us/patagonia.go?assetid=23429.

Suchman, J.R. (1962). *The elementary school training program in scientific inquiry.* Urbana: University of Illinois.

U.S. Agency for International Development. (2010). *Apparel training center in Haiti educates textile factory workforce.* Retrieved September 15, 2011 from http://blog.usaid.gov/2010/08/apparel-training-center-in-haiti-educates-textile-factory-workforce/.

U.S. Bureau of Labor Statistics. (2010). *Occupational outlook handbook (OHH), 2010-2011 Edition.* Retrieved September 15, 2011 from http://bls.gov/oco/.

U.S. Department of Education. (2010). *A blueprint for reform: The reauthorization of the Elementary and Secondary Education Act.* Washington, DC: U.S. Department of Education.

U.S. Environmental Protection Agency. (2008). *Municipal solid waste generation, recycling, and disposal in the United States: Facts and figures for 2008.* Washington, DC: Office of Solid Waste.

Utah State Office of Education. (2003). *Science 9-12: Earth systems science, biology, chemistry, and physics.* Salt Lake City: Utah State Office of Education.

Utah State Office of Education. (2007). *Mathematics 7-12.* Salt Lake City: Utah State Office of Education.

Yazzie-Mintz, E. (2010). *Charting the path from engagement to achievement: A report on the 2009 High School Survey of Student Engagement.* Bloomington, IN: Center for Evaluation & Education Policy.

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