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## **Increasing STEM Competence in Urban, High Poverty Elementary School Populations**

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### **Abstract**

Enhancing STEM competence (e.g., interests, knowledge, skills, and dispositions) among urban, high poverty, elementary school populations in the United States (U.S.) is and remains a growing national concern, especially since Science, Technology, Engineering and Mathematics (STEM) competence is and will continue to be a necessary requisite for gainful employment in the future, according to workforce development experts. In an attempt to address this gap, many urban elementary schools have begun to offer STEM-related programs to increase STEM learning at an early age. STEM competence (interest, knowledge, skills, and dispositions), however, remains low. This paper results in a matrix used to analyze children's fictional literary selections and a model that argues that elementary teachers, as the first point of contact with young students, can affect STEM competence. By adopting a more culturally responsive pedagogy that attends to the 21st Century Learning Skills and the Next Generation Science Standards, teachers can choose literature that serves to excite and reinforce STEM learning.

### **Introduction**

#### **Urban, High Poverty, Elementary School Populations**

There is a great national concern in the U.S. expressed over the lack of representation of African Americans, Hispanics, and other subgroup populations (e.g., low-income) in the Science, Technology, Engineering, and Mathematics (STEM) fields (Conklin, 2015; Jackson, 2016; Morrison, McDuffie & French 2015). These concerns led to an increased level of national funding being directed to schools and universities that agreed to increase efforts to recruit and retain students of color and low-income in the STEM fields. The number of African Americans participating in STEM education and STEM related careers, however, has not shown a significant increase (Conklin, 2015; Jackson, 2016; Kendricks & Arment, 2011; Morrison, 2015). Abdul-Alim reported that at the university level, "STEM degree completion rates along racial and ethnic lines remain stubbornly askew" (2013, p. 1). According to the Higher Education Research Institute (2010), completion rates vary among students pursuing their bachelor's degree in STEM education by race; White and Asian-American students had completion rates of 24.5 and 32.4 percent, respectively, while Latino and African-American completion rates were at 15.9 percent and 13.2 percent.

This lack of representation of African Americans, Hispanics, and other subgroup populations in the STEM fields served as an impetus for many urban, high-poverty, elementary schools to venture into providing curricular and extra-curricular STEM-related opportunities to students (e.g. STEM Summer Camps, STEM Days and STEM Schools). According to some researchers, the elementary school and elementary school children are the best targets for creating a greater level of STEM competence because academic subject matter can be more easily integrated in the younger grades, and curiosity and inquisitive natures are highest among younger children (Alumbaugh, 2015; Cantu, 2011; Honardoost, 2014; Isabelle & Valle, 2016).

According to the National Research Council (2011), STEM literacy is critical to living a productive and engaged life. "STEM literacy is the knowledge and understanding of scientific and mathematical concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity for all students" (p. 5). Although ambitious, early exposure to inquiry, reasoning, and problem-solving skills in science, technology, engineering, and mathematics (STEM) has the potential to stimulate and broaden participation of urban elementary students today and later in life, e.g., increase academic efforts in elementary, middle, and high schools; increase interest in pursuing a STEM-related higher education degrees; increase engagement in local communities; and increase preparation to become a viable member of tomorrow's workforce (Dejarnette, 2012; White 2013).

## **21st Century Skills and Next Generation Science Standards**

In the 21st century, all students need to meet with success in science, technology, engineering and mathematics (STEM) to become productive and contributing members of society (Ceballos, 2014; House Committee on Science and Technology, 2010; Lacey & Wright, 2009). This includes urban populations. *The Obama Education Plan* (2009) made clear that "80% of the fastest growing jobs require a knowledge base in math and science" (Obama, Manchester, N.H., November 20, 2007). According to the National Governor's Association (2007), however, many businesses and industries express concern that employment candidates are deficient in key STEM-related knowledge and skills. In order to increase competency levels of urban students in STEM fields, it is paramount that elementary schools focus on 21st Century Skills and Next Generation Science Standards.

**21st Century Skills.** Addressing the need to develop a more qualified STEM-competent workforce, the Partnership for 21st Century Skills developed a 21st Century Learning Framework that defines the 21st Century Learning Outcomes that students need to acquire to compete in the globally competitive workforce. These learning outcomes include: Content Knowledge and 21st Century Themes; Learning and Innovation Skills; Information, Media, and Technology Skills; and Life and Career Skills (2006).

*Content Knowledge and 21st Century Themes.* Students must master content knowledge in fundamental subject areas in the following disciplines: English, reading or language arts; world languages, arts, mathematics, economics, sciences, geography, history, government and civics. The academic content knowledge must be addressed by weaving 21st Century interdisciplinary themes into the curriculum: global awareness; financial, economic, business and entrepreneurial literacy; civic literacy; health literacy; and environmental literacy (Gay & Howard, 2000; Kay, 2010; Partnership for 21st Century Skills, 2008).

*Learning and Innovation Skills.* Students need to learn the innovation skills that drive the development of the U.S. economy. Innovation skills fuel the creativity required to create new products, make new discoveries, and for solving real-world challenges. In addition to problem solving, embedded within the learning and innovation skills are the essential 4 C's: creativity, communication, collaboration, and critical thinking.

*Information, Media, and Technology Skills.* Students need to be able to discern credible sources of information and be able to analyze and synthesize information and data, as well as learn to manipulate new media and technology as it develops (Partnership for 21st Century Learning, 2008). In order to function effectively in an information age society, it is critical that students learn to become information literate.

*Life and Career Skills.* Students must develop the emotional intelligence to work in today's team-based environments. Life and career skills are acquired through the practice of

collaboration, teamwork, and critical thinking (Mourshed, Farrell & Barton, 2012; Partnership for 21st Century Skills, 2008; Pink, 2006).

**Next Generation Science Standards.** The Next Generation Science Standards (NGSS) were developed as a result of the work done by the National Science Teachers Association, the American Association for the Advancement of Science, and the National Research Council and Achieve (National Science Teachers Association, 2013). The purpose of the standards is to help reduce science illiteracy of students in the U.S. by creating a common set of learning standards that should be taught at each grade level. Additionally, the standards are to help develop a greater interest in science among students so that they may more likely choose a science or technology major later in college. Each NGSS standard is based on three distinct and equally important dimensions: Practices, Core Ideas, and Cross-cutting Approach.

*Practice.* Practices describe the "doing" of science. They include such things as experimentation, pedagogy, and techniques used in the practice of science.

*Core Ideas.* Core ideas are those disciplinary core ideas that are key to each science domain. The four domains include: physical sciences, life sciences, earth and space sciences, and engineering.

*Cross-cutting Approach.* The Cross-cutting Approach to the study of science and engineering helps students explore connections among the Core Ideas that constitute scientific themes across all four domains. The Cross-cutting Approach has value because it provides students with connections and intellectual tools that help them to gain a greater understanding of the ideas.

### **Developing Culturally Responsive Pedagogy**

The social science construct human agency is worthy of consideration when investigating how individuals, in this case teachers, navigate constraints in their work environment in order to create and take meaningful and goal-oriented actions to advance student learning (Mehan, Villanueva, Hubbard & Lintz, 1996). Human agency as a construct is not new to the field of education. There is a well-established literature on transformative social actions that address marginalized student populations through the concept of human agency (Duncan-Andrade & Morrell, 2008; Giroux, 2001, Valenzuela, 1999). There are fewer studies, however, that investigate or focus on teachers as the agents of change aimed at creating needed pedagogical revisions designed to enhance student STEM competence (interests, knowledge, skills, and dispositions), especially of students in urban, high poverty, elementary schools, where most often the "pedagogy of poverty" is practiced. In order to move forward in increasing STEM competence for urban elementary students, the "pedagogy of poverty" needs to be addressed. While this methodology continues to be accepted, more innovative and culturally accepted approaches need to be utilized.

*Pedagogy of Poverty.* Dr. Martin Haberman (2005; 1995; 1991), a leading scholar in urban education, noted that while a variety of teaching methods can be found in any urban classroom, the pedagogy of poverty is the most dominant form of instruction. Often accepted as "good teaching" by teachers, administrators, and parents in urban communities, the pedagogy of poverty constitutes only basic mainstream teaching practices, e.g., giving information and directions to the students, making assignments and then reviewing them, asking questions, overseeing seatwork, assigning and reviewing homework, reprimanding defiance, settling arguments and quarrels, grading papers, giving tests, reviewing tests, and assigning grades. While these practices certainly occur in most schools throughout the U.S., these practices tend to be the only ones valued and expected in urban schools (Haberman, 2005). According to Haberman, state of the art progressive pedagogies that have been

tested and proven to be effective are far less often employed in urban schools (2005; 1995; 1991).

According to Haberman, because many adults from urban communities were not successful themselves in school, they have no reference or model for what constitutes great teaching (Haberman, 2005). In essence, they accept the pedagogy of poverty as good teaching. Haberman also posited that the pedagogy of poverty appeals to educators who, whether consciously or unconsciously, have low expectations of urban students, and who are unaware of other pedagogic possibilities. Without reservation Haberman stated that, "the pedagogy of poverty does not work" (p. 50).

The pedagogy of poverty fails to promote STEM dispositions in students, such as persevering through challenging tasks, being creative and innovative, collaborating with peers, and using problem solving and reasoning skills to tackle real-world situations (National Research Council, 2011). If these dispositions are to be developed, an alternative pedagogy must be developed and practiced.

*Culturally Responsive Pedagogy.* An alternative to the pedagogy of poverty is the "culturally responsive pedagogy." Culturally responsive pedagogy is defined as the attempt to use cultural knowledge, past experiences, performance styles, and the strengths of students to build a foundation of learning. This pedagogical approach holds the potential to enhance the STEM competence (interests, knowledge, skills, and dispositions) in students of color (Gay, 2000; Layne, Tremion & Dervin, 2015; Taylor & Sobel, 2011). By embracing culturally responsive pedagogy as an instructional practice, urban, high poverty, elementary students can begin to build STEM competence which will serve them throughout their academic career. Additionally, students likely will develop the motivation and confidence to pursue STEM-related careers later in life (Howard & Terry, 2011; White, 2013).

Culturally responsive pedagogy stimulates STEM competence in students by building a bridge between culture, effective teaching, and effective learning (Arens, 2010; Lee, 2007; Lee, Spencer, & Harpalani, 2003; Nieto, 2010). Howard and Terry (2011) reported that culturally responsive pedagogy is not simply teaching acts. Rather, culturally responsive pedagogy is built on embedding the indigenous culture of targeted students into the practices of curriculum development, lesson planning, and lesson delivery. Culturally responsive pedagogy reflects an outlook that personifies respect for cultural and ethnic ideologies. Instead of advocating for basic mainstream beliefs about teaching, as is the case with pedagogy of poverty, culturally responsive pedagogical teaching values life experiences that students bring from home and acknowledges and incorporates these experiences in the context of the classroom, which results in enhancing the academic experiences and achievement of culturally diverse learners (Baskerville, 2009; Gay, 2000; Gist, 2014; Ladson-Billings, 1995; Nieto, 2010; Sobel & Taylor, 2011).

The belief behind this instructional practice is that culturally responsive pedagogy enables culturally diverse students to meet success through cultural associations, previous experiences, and personal reference points that help to develop and define students' level of self-efficacy (Baskerville, 2009; Gay, 2000, 2010; Gist, 2014; Sleeter, 2011; Sobel & Taylor, 2011). Culturally responsive pedagogy "acknowledges the legitimacy of the cultural heritage of different ethnic groups" (Gay, 2010, p. 31). Based on research in the literature, being more culturally sensitive to students leads to greater student engagement and enhances learning (Baskerville, 2009; Gay, 2000; Gist, 2014; Sobel & Taylor, 2011). Gay (2000) asserted that if teachers develop the ability to incorporate cultural sensitivity in curriculums and teaching strategies, "students of color can maintain identity and connections with their ethnic groups and communities, [while] developing a sense of community, camaraderie, and shared responsibility" (p.32). Wigfield, Lutz, and Wagner (2005) and Gay (2010) concluded that when urban students' interests and sociocultural existence becomes connected to their

academic school experiences, students will become more empowered and take more ownership and control of their own learning.

### **Integrating Literature**

There are endless opportunities for establishing bridges between cultures and pedagogy. In the African American culture, the practice of storytelling and the use of rhythmic patterns, motion, movement, music, are commonly used as forms of expression; therefore, the use of these forms of expression in developing and delivering culturally relevant STEM-related lessons would be appropriate. The practice of scaffolding assignments also can contribute to improving communications, motivation, and confidence. By chunking or breaking down a large assignment into smaller more manageable tasks, students will less likely become overwhelmed by the assignment, and instead, experience academic success that leads to building academic motivation and confidence (Allen & Butler, 1996; Benson & Chik, 2014; Hanley, 1998; Matthews, Gauld, & Stinner, 2004).

Several investigations that focused on the inclusion of culturally responsive literature in non-STEM academic content areas have shown positive impacts. The Multicultural Literacy Program (MLP) implemented in Ann Arbor, Inkster, and Ypsilanti, Michigan, investigated the impact of culturally responsive pedagogy in improving reading and writing. In this study, teachers were divided into treatment and non-treatment groups. Teachers in the treatment group received professional development training on reading and writing strategies, and received additional training on methods for integrating culturally-relevant literature. The treatment group spent approximately ½ hour daily with the literature, while the control group only used their basal readers. Based on qualitative research results, fourth, fifth, and sixth grade students associated with the treatment group of teachers, demonstrated greater interest and enjoyment in literature, and developed more positive attitudes towards reading and writing (Diamond & Moore, 1995).

Given the positive effects of integrating culturally responsive pedagogy in non-STEM academic content areas, it is reasonable to believe that linking literature to STEM-related content areas may lead to increasing STEM competence (interests, knowledge, skills, and dispositions) among urban, high poverty, elementary school students. There is research that links literature to the study of mathematics. Results indicate that such linkages provided opportunities for students to connect abstract ideas to real-world experiences students encounter which enhances their understanding (Burns & Sheffield, 2004; Kinniburgh & Byrd, 2008; NCTM, 2000; Szilagi & Zarazinski, 2012). The same may hold true for linking literature to STEM-related disciplines. To date, however, there is limited research that investigates such linkages. Although not an exhaustive list, advantages and strategies for linking literature to STEM are presented and briefly discussed below.

### **Developing a STEM Approach and Vocabulary**

The STEM-related disciplines involve many principles and ideas, especially in engineering, that are not typically addressed in an elementary school curriculum. Pneumatics and hydraulics, for example, engineering terms that describe trapped air and liquid under pressure, are rarely discussed in elementary school. However, these concepts are presented in a literary selection entitled *Sustainable Energy Sources of Ireland* (2014). This selection could be coupled with a mathematics lesson on measurement, or the science of forces and energy. In the literary selection *Pythagoras and the Ratios: A Math Adventure* (Ellis, 2010), a number of STEM-related and engineering concepts are presented. The design principles in the book could easily be paired with hands-on-intensive, age-appropriate STEM-related build, test, and retest activities. In *Wood-Hoopoe Willie* (Kroll, 1995), a story about an enthusiastic African-American child who discovers the rhythms of African drums, students could design and make a drum or a lyre using engineering design principles and geometric

topics. After building the instruments, students could explore the science of sound by measuring sounds waves with the use of sound level meter, take measurements and graph data, and identify similarities and differences among the instruments they make.

### **Promoting Problem Solving and Reasoning Skills**

The mathematical process standards (NCTM, 2000) and more recently the Standards for Technological Literacy (ITEA, 2007), 21st Century Skills, and Next Generation Science Standards (Common Core State Standards Initiative, 2010; Next Generation Science Standards Lead States, 2013; Partnership for 21st Century Skills, 2008) identify problem solving and reasoning as integral components for STEM-related learning. These practices also promote inquiry teaching and learning that endorses critical, analytical, and logical thinking, all areas needed for STEM competence.

In support of these practices, the State Educational Technology Directors Association's (SETDA) (2014) states that their mission is to improve all areas of education through technology and practice. The National Society of Professional Engineers (NSPE) (2014) is committed to teaching innovation that promotes creative problem solving through math, science and engineering. Collectively, the missions of these professional organizations are to advance student STEM competence and to assist teachers in the development of hands-on-intensive real-world challenges that require problem solving, inquiry, and reasoning. In *Designing Dandelions: An Engineering Everything Adventure* (Hunt & Pantoya, 2013), the authors take the readers through an adventurous journey in which the characters in the book see analogies in the dandelion lifecycle that helps them to develop a spacecraft. With the use of this book, students will begin to see how nature itself can be used to instruct them in engineering design principles.

### **Promoting STEM Discourse**

Culturally responsive teaching utilizes constructivist approaches to teach concepts (Dover, 2013). The practice of offering students opportunities to engage in expressive conversations supports culturally responsive pedagogy by allowing students to contribute original ideas based on their cultural experiences (Nathan & Knuth, 2006). Promoting discourse about STEM ideas also complements the development of social interactions and participation, skills often used in team problem solving (Blanton, Berenson, & Norwood, 2000). Discourse in the classroom encourages the development of and an appreciation for the ideas of others and students begin to see that the adage 'not one of us is as smart as all of us' is often correct; that the best solution is often based on collaboration (Stein, 2007). Vygotsky (1987) reported that student discourse kindles higher thinking processes through the internalization of student interaction. According to Subramaniam, Ahn, Fleischmann, & Druin, (2012), "How one talks about science, does science, learns about science, and aspires to pursue science is influenced by prior life experiences, social circumstances, and home life, which are inextricably related to factors such as race, gender, and socioeconomic status" (p. 165). For underrepresented students, these conversations most likely will take place in classrooms where students can be encouraged to develop STEM-related habits of the mind.

In order to help students practice this type of discourse, teachers can use the book *Pythagoras and the Ratios: A Math Adventure*. During story time, teachers can ask students to discuss what Pythagoras did to fix the musical pipes of his cousin Octavius, which were making terrible noises. Teachers could ask students, what did Pythagoras do to cause the pipes to turn into instruments that made beautiful music, which lead to Octavius winning the music contest. With a stylus, clay tablet, measuring cord and his sharp wits, mathematician-to-be Pythagoras figures out the relationship between pipe length and the resultant sound, and fashions a perfectly pitched set of pipes. Teachers could even pair the books,

*Pythagoras and the Ratios with Willie in Wood-Hoopoe*, and ask students to identify common challenges and insights Pythagoras and Willie discovered.

### **Developing Latent Talents and Positive Dispositions**

In this era of high-stakes testing, latent talents are often overlooked and are rarely emphasized or nurtured in the elementary urban classroom. Yet, these are the talents that have the potential to sustain students' interest in STEM-related instruction and serve as a foundation. Developing trust and working as a team, risk taking, persevering, acting with integrity and ethics are characteristics and types of behavior required of effective teams often employed in engineering, as well as in other STEM-related careers (National Research Council, 2011). Teachers must invest time and effort in cultivating these latent talents to capitalize on students' interests and capabilities. A literature selection that highlights these character skills and talents is *A Single Shard* (Park, 2011). This literary selection emphasizes persistence, determination, and problem solving. Another selection that emphasizes the need to develop talents through persistence is *Try, Try Again* (Hallinan, 2011). In this selection, students come to learn that effort and persistence are the hallmarks of hard work which is required to accomplish many feats. For the younger grades, *Little by Little* (Stewart, 2008) and *Lucky Beans* (Becky, 2010) illustrates the positive impacts of determination.

### **Methods**

**Participants:** Three faculty in STEM education participated in this study. In addition, one faculty member participated from elementary language arts education.

**Design of the study:** A two phase quasi-delphi study was designed and implemented. This design allowed the researchers to identify fictional literary selections that depicted 21st Century Skills, were related to the Next Generation Science Standards, and supported culturally responsive pedagogy.

**Measures:** During the first phase, individually and then collaboratively, the STEM education faculty identified elementary math-, science, engineering-related fictional literary selections that depicted 21st Century Skills. The 21st Century Skills considered were: learning and innovation skills. e.g., creativity, communication, collaboration, critical thinking, and problem solving; information media and technology, e.g., analysis of synthesis of data, manipulation of new technology; and life/career skills. e.g., growth in emotional intelligence.

In the second phase, the STEM faculty, initially working alone and then in collaboration, listed, discussed, and agreed on the strategies and goals to implement culturally responsive practices that reflected the indigenous experiences of urban, high poverty, elementary school children.

### **Results**

#### **Stimulating Interest in STEM Careers**

Many urban, high poverty, elementary schools students are rarely exposed to STEM concepts for various reasons. Given that the pedagogy of poverty dominates how teaching is approached in urban schools, students often experience failure and come to believe that abilities, not effort, largely determines success (Haberman, 2005, 1995; Kozol, 1991). According to Haberman, a hallmark of effective teachers is that they believe that "effort not ability" determines success; "Success is more frequently and more closely associated with effort than with inherent ability" (Haberman, 2005, p. 106). It is unfortunate that many urban students explain success as having "ability, luck, family connections, and knowing the right people" (Haberman, 2005, p. 107). Effort is often left out of the discussion when urban students talk about what determines success. If literature that advocates curiosity and hard work could be introduced, students could begin to understand that it is not ability alone that



impacts success, but that their effort is a critical factor. *Engineering Elephants* (Hunt and Pantoya, 2010) introduces young students to different STEM-related principles and careers, including the reiterative process of build, test, and retest that requires significant effort and determination. The books *Electrical Wizard: How Nikola Tesla Lit Up the World* (Rusch, 2013), and *Turn on the Lights - From Bed!: Inventions, Contraptions, and Gadgets Kids Can Build* (Carrow, 1996) also introduces students to STEM-related and engineering design concepts and processes that are effort intensive.

Sharing biographies of African American men and women in STEM-related fields who struggled in their efforts to make science and math discoveries and solve problems, helps students to see the importance of effort, as well as illustrates many STEM-related practices. Books about historical and present day figures such as Benjamin Banneker, George Washington Carver, Neil deGrasse Tyson, and Ben Carson serve to inspire all students, and most especially African American students, who, like the subjects of these books, are people of color. Books like *The Scientists Behind Space* (Hartman, 2010) and *What Color is My World?: The Lost History of African-American Inventors* (Abdul-Jabbar & Obstfeld, 2012) highlight several African American male and female scientists and inventors, including Ellen Ochoa, Carolyn Shoemaker, Granville Woods, and James West.

Literature has long been used as a motivator for engaging children in learning opportunities (Gilton, 2007). Exposure to STEM-related books that discuss STEM and practices could help students to develop a greater conceptual understanding of STEM and of the efforts required to be successful in STEM (Common Core State Standards Initiative, 2010; NGSS Lead States, 2013). Table 1 summarizes a few of the aforementioned children’s literature selections and potential STEM practices that may be used for developing a conceptual understanding of STEM-related ideas during or after engaging with the literature selections. Culturally responsive practices are also included in the table.

**Table 1.**

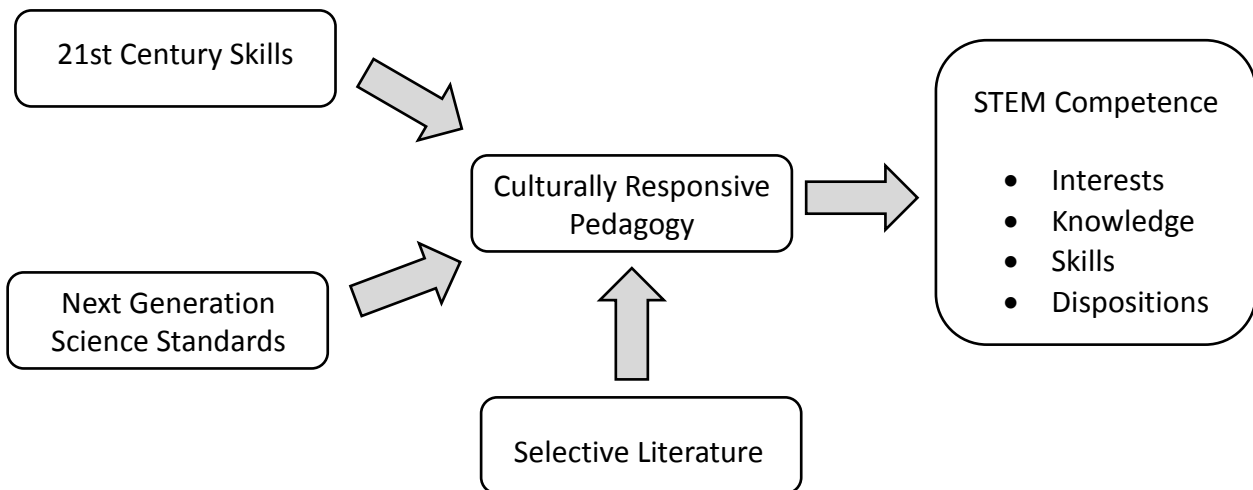
*Incorporating Literature with STEM Principals through Cultural Responsive Practices*

<i>Title, Author</i>	<i>Potential STEM Practices</i>	<i>Suggested Cultural Responsive Practices</i>
<i>Lucky Beans</i> , Becky Birtha	Problem solving, innovation	Storytelling
<i>Electrical Wizard: How Nikola Tesla Lit Up the World</i> , E. Rusch	Team work	Cultural values, build relations, incorporate multicultural information
<i>Pythagoras and the Ratios: A Math Adventure</i> , Julie Ellis	Mathematical relationships and other connections	Storytelling, music, everyday-life concepts
<i>Designing Dandelions: An Engineering Everything Adventure</i> , E. Hunt & M. Pantoya	Engineering design process, scientific life cycles, constructing physical models, problem solving, and reasoning	Builds bridges between home and school experiences, connect academic abstractions and sociocultural realities
<i>Turn on the Lights - From Bed!: Inventions, Contraptions, and Gadgets Kids Can Build</i> , R. Carrow	Innovating, problem solving, and reasoning in real life situations	Facilitating interactions and creativity, habits of curiosity and inquiry and decision making
<i>A Single Shard</i> , L.S. Park	Problem solving, persistence, and determination	Risk-taking within a safe environment

## **A New Direction for Urban, High-Poverty Elementary Schools and STEM Education**

Obama's Education Plan highlights that "Innovation has no limits" (2009). Although the United States is not identified as one of the top nations in mathematics and science based on international test scores (Institute for Educational Statistics, National Center for Educational Statistics, 2015), it is "ranked atop all nations on indices of global competitiveness, and American workers are deemed the most productive in the world" (Gerald Bracey in Obama, 2009, p. 81). Gerald Bracey (2009) stated, "Innovation is the one aspect of economic competitiveness that does not at some point show diminishing returns" (p. 81). Given that international, national, and state mandated tests do not measure such qualities as creativity, ambition, and innovation, these talents are often overlooked or not encouraged in the urban elementary classroom but should be if students are to be inspired to pursue STEM-related fields.

STEM competence (interests, knowledge, skills, and dispositions) can be enhanced by teachers attending to the 21st Century Skills, Next Generation of Science Standards, and incorporating appropriate literature that supports the development and implementation of a culturally responsive pedagogy (Figure 1).



**Figure 1.** The relationship of elements that impact increasing STEM competence (interests, knowledge, skills, and dispositions) in urban, high poverty, elementary school populations.

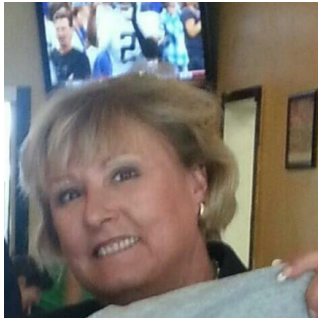
### **Discussion**

By developing and implementing a culturally responsive pedagogy, teachers build on the strengths and talents of urban elementary students, the experiences they bring from home, and the experiences that they bring from their communities. Reiterating, culturally responsive pedagogy has been shown to demonstrate that it impacts student effort and engagement in academic pursuits (Howard, 2001).

Learning to teach well is recognized as a change process that requires professional learning opportunities and support throughout the continuum of a career, at all stages (Sykes, 1999; Feiman-Nemser, 2001). Whether change occurs as a function of teachers' maturation in aims and abilities (Moir, 2003; Moore Johnson & Birkeland, 2003) or as shifts in the political, economic, and social environments in which they work, it is clear that teachers must change their pedagogical approach based on their targeted audiences, their students, in order to enhance student learning (Anderson & Olsen, 2006). In this paper, the need to increase students' STEM competence (interests, knowledge, skills, and dispositions)

required of tomorrow's workforce, necessitates the need to change pedagogy today, especially in urban, high poverty, elementary schools.

Much needs to be done now to build an awareness among teachers and administrators so that they will be supportive of the time and effort it will take for teachers to create a culturally responsive pedagogy; much also needs to be done now to encourage teachers to break the cycle of using the "pedagogy of poverty" and instead, encourage them to embrace the more effective culturally responsive pedagogy; and much needs to be done now to encourage students to believe that their effort impacts their academic success today and tomorrow.



***Sueanne McKinney*** : Associate Professor, Elementary Education, Old Dominion University. Author of *Mathematics in the K-8 Classroom and Library*. Dr. McKinney's area of teaching and research is elementary methods and mathematics. Her area of expertise includes developing teachers for and encouraging STEM education of students in urban high-poverty schools.



***Cynthia Tomovic*** : Professor, STEM Education and Professional Studies, Old Dominion University. Dr. Tomovic teaches, conducts research, and consults with organizations in the areas of leadership development and performance improvement, and globalization. She is director of ODU BLAST, an Old Dominion University residential, hands-on, summer STEM program designed to build leaders to advance science and technology for high school students.



***Melva Grant*** : Associate Professor, Mathematics Education, Old Dominion University. Dr. Grant teaches courses to elementary & secondary mathematics pre- and in-service teachers. Her research, consulting, and development work is focused on broadening participation in STEM fields for underrepresented populations.



**KaaVonia Hinton:** Professor, Language Arts, Old Dominion University. She is the co-author (with Katherine T. Bucher) of *Young Adult Literature: Exploration, Evaluation and Appreciation*, and co-author (with Sueanne McKinney) of *Mathematics in the K-8 Classroom and Library*.

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