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UNDERSTANDING ADOLESCENT STUDENT PERCEPTIONS

OF SCIENCE EDUCATION

by

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A dissertation submitted in partial fulfillment
of the requirements for the

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ABSTRACT

Understanding Adolescent Student Perceptions of Science Education

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This study used the *Relevance of Science Education* (ROSE) survey (Sjoberg & Schreiner, 2004) to examine topics of interest and perspectives of secondary science students in a large school district in the southwestern U.S. A situated learning perspective was used to frame the project. The research questions of this study focused on (a) perceptions students have about themselves and their science classroom and how these beliefs may influence their participation in the community of practice of science; (b) consideration of how a future science classroom where the curriculum is framed by the *Next Generation Science Standards* might foster students' beliefs and perceptions about science education and their legitimate peripheral participation in the community of practice of science; and (c) reflecting on their school science interests and perspectives, what can be inferred about students' identities as future scientists or STEM field professionals? Data were collected from 515 second year science students during a 4-week period in May of 2012 using a Web-based survey. Data were disaggregated by gender and ethnicity and analyzed descriptively and by statistical comparison between groups. Findings for Research Question 1 indicated that boys and girls showed statistically significant differences in scientific topics of interest. There were no statistical

differences between ethnic groups although. For Research Question 2, it was determined that participants reported an increase in their interest when they deemed the context of the content to be personally relevant. Results for Research Question 3 showed that participants do not see themselves as youthful scientists or as becoming scientists. While participants value the importance of science in their lives and think all students should take science, they do not aspire to careers in science. Based on this study, a need for potential future work has been identified in three areas: (a) exploration of the perspectives and interests of non-mainstream students and urban students whose representation in this study was limited; (b) investigation of topics where students expressed low interests topics; and (c) development and design of authentic communities of practice in the science classroom.

Keywords: Interest, Perspectives, ROSE

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DEDICATION

To my family who persisted with me.

To my friends who listened patiently.

To all the students who sit in science classrooms around the country wanting to participate and be involved in their science education, you have a voice.

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Chapter 1

For the past 20 years, the achievement of American students on international measures of science achievement have flat-lined while adolescents matriculating from high schools across the nation elect not to pursue university degrees in science, technology, engineering, and mathematics (STEM) (Lee & Buxton, 2010; National Center for Educational Statistics, 2010; National Science Board, 2000). This problem is a global phenomenon that many countries are struggling to address (DeBoer, 2010; Duschl, 2008; Millar & Osborne, 1998; National Academy of Science, 2007; United Nations Educational and Cultural Organization [UNESCO], 2009); however, within the United States, analysis reveals that challenges in science education are multi-faceted, complex and exacerbated by different policies and practices. Predominantly the enactment of the *No Child Left Behind Act of 2001* (NCLB) and its resultant policies have impacted areas such as course taking and resource allocation (ACOT, 2008; DeBoer, 2010; Lee & Buxton, 2010). The *No Child Left Behind Act* (2001) has inadvertently had the side effect of limiting opportunities for many students to learn science (DeBoer, 2010; Hogrebe & Tate, 2010; Lee & Buxton, 2010). These impacts have been especially evident in schools with high percentages of minority students, second language students, and students of poverty (non-mainstream students) (Hogrebe & Tate, 2010; Lee & Buxton, 2010).

There is evidence that for certain populations of students in urban, suburban and rural schools, opportunities to engage in high quality science have been hampered by NCLB (2001) assessments (Blank, 2012; Tate, Clark, Gallagher & McLaughlin, 2008).

Students identified as not meeting NCLB (2001) requirements experience frequent pullout from their normal class schedule for remediation and are often counseled to take less rigorous courses (Cataldia & Ramani, 2009; Tate, 2001). Students in high risk schools experience course tracking and continuous, repeated content review to pass high stakes testing, which has limited the available time that could have been used to provide them with the opportunity to experience grade-level, high-quality, standards-based science instruction (Cataldia & Ramani, 2009; Tate, 2001).

In terms of resource allocation, staffing, scheduling and interest, NCLB (2001) has had multiple impacts on science education, which begin to surface during elementary school where an emphasis on reading and mathematics has severely curtailed the time spent on instruction in other content disciplines including time spent on science instruction (Blank, 2012; Lee & Buxton, 2010; Seiler, 2001). The National Research Council (NRC) (2011) stressed the importance of sustained experiences and instruction for science students at all grade levels; however, even students who demonstrated proficiency on mandated assessments have been deprived of early experiences in science because their teachers have been focused on mathematics and English language arts instruction.

The failure of elementary schools to introduce science content is compounded as students advance to middle school (Change the Equation, 2011). As middle school teachers struggle to teach both elementary and middle school science standards, the quality of student experiences is diminished (Lee & Roth, 2009). The situation is perpetuated into high school where the lack of grade-level K–8 science education including science investigations and inquiry has left many students unfamiliar with

science, including its practices, and unable to participate in academically rigorous high school science, resulting in frustration and a loss of interest in the discipline (Lee & Buxton, 2010; Tate, 2001).

Research has shown that many students make decisions about course taking and future occupations as early as upper elementary and middle school (Jenkins, 2006; Simpson & Oliver, 1990). Students with limited experience in science have little basis for making important choices about their education. They leave school understanding little about the enterprise of science and sometimes with negative attitudes (Simpson & Oliver, 1990). Without the rich experience afforded by science investigations and inquiry, students are not necessarily predisposed to identify with the field. They do not see themselves as having the ability or skills to be a scientist (Schreiner & Sjoberg, 2004).

Schreiner and Sjoberg (2004) suggested that the school science experience for many high school students is distant, abstract, and even unattainable. Students who have been chronically under-prepared have been tracked into non-productive courses and, if they fail state mandated tests, are placed into remediation courses (Cataldia & Ramani, 2009; Tate, 2001). A high school science experience that is vocabulary-laden, lecture driven, and based on experiences that are irrelevant to their interests and daily lives (Seiler, 2001) further complicates the issue for these students. In essence, many students find school science to be boring and difficult (Schreiner & Sjoberg, 2004). Duschl (2008) supported this claim and suggested that the idea that science is about the "manipulation of objects and materials to engage learners with phenomena to teach what is known, embodies the disconnected, modularized, hands-on and textbook approaches" (p.1) that has come to characterize science instruction since the 1960s.

A significant challenge for science educators is to better understand how students' interests relate to societal needs and issues and how these interests can be used to promote equitable learning opportunities (NRC, 2011; Sadler, 2009). Recent research has shown that when science was connected to students' interests, many students were quite engaged and very interested in pursuing science careers. In studies of underdeveloped countries, many students believed that careers in science can help advance themselves and their communities and were motivated to pursue more science classes (Anderson, 2006).

Definitions of Terms

Table 1 lists and defines terms used that are frequently throughout this document.

Table 1

Definitions Used in This Study

Term	Definition
Community of Practice	Groups of people who have a shared passion or concern for something they do together and through their regular interactions, they learn how to do it better (Lave & Wenger, 1991) eventually becoming experts. Members enact the conceptual and physical tools used by the community.
Cognitive apprenticeship	The engagement of students in tasks appropriate to the community of practice and which are slightly more difficult than they can individually manage requiring that they work collaboratively with their peers and perhaps their teacher in order to be successful.
Identity	Identity refers to how the student learns to speak, act and develop relationships and artifacts with respect to members of the community of practice.
Legitimate peripheral participation	The engagement of a learner (novice) through incremental authentic activities into a community of practice (experts) such that the learner gains competency and skill in the community's culture, norms and practices. In the community of science, novices learn the science and engineering practices which include asking and defining problems, developing models, communicating using scientific language, analyzing and interpreting data, engaging in argument, communicating information, using mathematical thinking, and constructing explanations.
STEM	Science, Technology, Engineering and Mathematics

Purpose and Rationale for the Current Study

It was the intent of this study to explore the science interests and perspectives of tenth grade students in a large school district in the southwestern U.S. The goals of this study included: (a) identifying students' interests in and perspectives about their school science experiences, (b) describing how their interests might influence the design of a future science classroom based on the pending *Next Generation Science Standards* (NGSS) (Achieve, 2012), and (c) using their science topics of interest to infer the accessibility of the existing community of practice of science.

This study used a situated learning perspective to articulate participants' interests such that their views could enlighten policies and practices that describe ways in which science and technology education could be designed and taught. It endeavored to better understand science education from the perspective of science students, especially students in identified underserved populations such as Hispanic and African American students. Results from the National Assessment of Educational Practice (NAEP) (2009), indicated that science achievement among Hispanic and African American students, identified as underserved populations of students, lagged behind Asian and White students across the nation and also in the study school district (Change the Equation, 2011). It was important to explore how Hispanic and African American student participants viewed science and whether their interest in science was related to their experience in school science especially given that research identified that when surveyed, minority students hold positive attitudes towards science but not school science (Tate et al., 2008).

This study was timely given that the National Academy of Science was developing a new set of science standards, the *Next Generation Science Standards* (NGSS), scheduled for publication in spring 2013. The NGSS is grounded in *A Framework for K–12 Science Education* (National Research Council, 2011) and represents a new reform for science education. As a guiding document, the *Framework* differs from the *National Science Education Standards* (1996) in that it is grounded in six guiding principles which include "(a) children are born investigators; (b) a focus on core ideas; (c) the development of true understanding over time; (d) consideration of both knowledge and practice; (e) the linkage of science education to students' interests and perspectives; and (f) the promotion of equity" (NRC, 2011, p.24). It is anticipated that new science curricula will be designed and developed with the publication and adoption of the NGSS by states. This opportunity provides schools and districts the prospect of envisioning science instruction that focuses on the practices of scientists and thus on the cognitive apprenticeship of young students. There was a potential in this study to provide a model for how students' perspectives and interests could influence the design of new science curriculum and pedagogical practice.

The proposed study was situated in a large school district in the southwestern U.S and explored the science topic interests of science students through the following research questions:

1. What perceptions do students have about themselves and their science classroom and how might these beliefs be influencing their participation in the community of practice of science?

2. Considering a future science classroom where the curriculum is framed by the Next Generation Science Standards how might the standards foster students' beliefs and perceptions about science education and their legitimate peripheral participation in the community of practice of science?

3. Based on their school science interests and perspectives, what can be inferred about students' identities as future scientists or STEM field professionals?

The Study District. In order to maintain the anonymity of participants and their school district, the pseudo-name *study district* will be used and no references that directly reveal the identity of the district will be cited in this document. Further, the pseudo-name, *study state* or *State* will be used in lieu of the proper name of the state that contains the study district. The study district is a large school district of over 300,000 students located in the southwestern United States. The study district has more than 40 high schools, including rural, suburban and urban schools. Many of these schools have specialty magnet programs such as biomedical, engineering, or career and technical education programs. Science teachers in this district teach standards–based science as articulated in their curriculum documents.

In the study district, students can fulfill their graduation requirements with either a standard or advanced diploma. Matriculation with a standard diploma requires completion of two science classes, and the curriculum for these courses may or may not cover the entire 9–12 grade band of state science content standards. Students graduating with an advanced diploma are required to take three science classes, two of which must be laboratory–based and include biology (Study District Regulation, 2007). Students who fail their state high school science test are required by district policy to take a remedial

science class. This class is designed to assist students in passing their graduation exam and is primarily designed as a review course; however, students do receive science credit for the course.

Theoretical Framework

Situated learning served as the theoretical framework for this study. Situated learning emphasizes the socio-cultural contexts in which learning occurs and focuses on the enculturation of the learner into the community through authentic activities. Lave and Wenger (1991) used the example of a child who accompanied her midwife grandmother participating in her grandmother's craft by first assisting and running errands while over time learning how to be a midwife herself. As the child grew and became more skilled in the work of a midwife, she eventually moved from her novice status (apprenticeship) to an expert status when she delivered her first baby. This enculturation process was slow and iterative but the tasks were real and meaningful to the community of practice. The child's invitation to learn midwifery was accomplished through her participation in the practices of the midwife (legitimate peripheral participation). It was the task of her midwife grandmother to develop the child's skill by continuously increasing the sophistication of the tasks that the child performed.

In this study, a situated learning perspective permitted the exploration of how students' interests might align with those of the community of practice of science, and how the district science course syllabi, which teachers used, might enable them to create student experiences which support these identified interests and foster student identities as youthful apprentices. Further, this study endeavored to understand how a classroom based on the *Next Generation Science Standards* (NGSS) (Achieve, 2012) would support

students' interests through the standards' design, intentional focus on equity, and student identity development.

Situated learning has three essential features that include: (a) A social and material context; (b) activities and interactions; and (c) participation and identity (Johri & Olds, 2011). Learning occurs within a socio–cultural context through problem solving, imitation and engagement in authentic activities (Lave & Wenger, 1991). Learning is not simply an amassing of knowledge, but a maturation of individuals, as they move from novice status through legitimate peripheral participation (apprenticeship activities) towards full membership in a community of practice of the experts (Hmelo & Evensen, 2000; Lave & Wenger, 1991). Knowledge is constructed in context and is not transmitted from one person to another (Orgill, 2007).

In a classroom designed with a situated learning perspective, one might expect to see the essential characteristics evident as students engage in scientific practices and activities such as initiating scientific questions, engaging with their teacher (the expert) and fellow students about their study questions, designing methods in which to gather their evidence, manipulating materials, collecting data as supporting evidence for their ideas, developing models as ways in which to interpret and analyze their data, and thinking about how to articulate and communicate their understandings. The science classroom viewed this way is dynamic and robust; dialog is a key feature. The classroom has its own culture, which encompasses the sub–cultures of its participants.

Situated learning provides a window through which to view science education at its ideal. If students are considered to be youthful apprentices working to develop their skills as members of the science community, then students should come to understand

through incremental, authentic activities and challenges that science has common practices, language and knowledge. A classroom should at its best, model the practices, languages and activities of the science community. In this way, students engaged in science use the practices in a coherent way. Their science language development mirrors the language and discourse of the science community. Students learn how to ask and formulate questions, design investigations and communicate evidence–based findings. The curriculum syllabi used by teachers are formulated with the intent to bring students into the community of practice of science by developing skills, which are transferrable in their future science courses and in their daily lives. It would also be important for the teacher using a situated learning perspective to connect the skills and practices of the community of science to the interests of students helping students understand how science is connected to their lives and how science career opportunities can lead to fulfilling and meaningful careers.

Johri and Olds (2011) examined how engineering courses could be designed using a situated learning perspective and argued that the learning context of the classroom must engender student identities as engineers. They asserted that if engineering identities were fostered for some students and not others, then all students were not being served, and in the long term this lack of equity hindered the engineering field. Equity issues must continually be addressed. They asked, "How does the structure of the (engineering) practice influence access to knowledge about engineering, practices of engineering and identity of engineers" (p.166)? The school science community must also ask the same question about the learning context for fostering the science identity of their students. It becomes a responsibility to be shared by the community of practice of science to ensure

that the classroom atmosphere, the practices of science, the structured scientific discourse (dialogic processes) and associated curriculum materials always lead to the strengthening of student identities as young scientists. One way to assure this is to query students on a continual basis assessing their views, interests and progress as young science apprentices.

In the study district's high school science classroom, the textbook, the district syllabi and the available supplies are typical resources available to the science teacher. The teacher determines the design of the school science experience for her students. Choosing a lecture–centered learning design will not afford students legitimate peripheral participation in the community of practice of science as advocated by the inquiry standards of the NSES (1996) nor does it ensure that they will engage in scientific exploration or discourse that will help shape their scientific thinking. Given the demands of teaching, most teachers are probably not familiar with situated learning and as such, probably have not considered how the essential features of situated learning could change the design of a classroom. Thus, the essential characteristics needed in the creation of an apprentice–like classroom environment, based on the culture and language of the community of practice of science, are not developed. Students do not have the opportunity to gain the competencies needed to be full members of the community of practice of science. Their fledgling interests in science are not fostered and incrementally developed because they do not access the practices and norms of the community.

For this study, a situated learning perspective afforded an exploration of whether students' science topics of interest aligned with the community of practice of science and whether the science course syllabi, which govern the curricula that the students experience, supported these identified interests as characterized by the community of

science. This study endeavored to understand how the NGSS could support students' interests through the design of the standards and the attention on equitable opportunities for all students.

The ROSE Survey

This study used the Relevance of Science Education (ROSE) survey, a measure of student interest, which has been widely used internationally. The ROSE is a comprehensive questionnaire of 228 items focused on topics that students may find interesting. For the past 10 years, this questionnaire has been used with 14, 15 and 16 year old, second year science students from countries around the world. Over forty thousand students have completed the ROSE survey and their responses have enlightened educators' understandings about what students around the globe find interesting and how boys and girls in this age group view their world and the ways in which their world is influenced by science and technology.

For this study, it was intended that the students' responses to the ROSE survey, when viewed through a situated learning perspective, would further enlighten the understanding of the interests of students in a large urban center and as such, support inferences about potential issues with adoption of the NGSS in the United States. The NGSS will focus on practices of science and engineering as well as content and crosscutting concepts unique to science. Development of curricula to implement these standards can take advantage of students' interests and foster their invitation to the community of practice of science. For this project, participants' perspectives can contribute to a model of contemporary school science that builds on early experiences

with the practices of the science community and the notion of youthful science apprentices.

Characteristics of Science Education in the Study District

In 2007, approximately 66% of secondary students in the United States earned a high school diploma (Olsen, 2007). National data demonstrate that significant disparities exist among different socioeconomic and ethnic groups across the country (National Center for Education Statistics, 2009), which is also mirrored in the study district. Lynch (2010) reported, "because students of color attend high poverty schools at higher rates than White or Asian American students, a large part of this problem, identified as the Achievement Gap, is economic and systemic" (Lynch, 2010, p. 318).

Data from the National Assessment of Educational Progress (NAEP) were not available for study district; however, 43% of eighth graders in the study state scored below Basic on the science portion of the 2011 test compared with a 38% national average. NAEP scores are reported as scale scores and achievement levels. NAEP achievement levels are Basic, Proficient, and Advanced. On the 2011 NAEP assessment administered in the study state, 69% of African American students and 57% of Hispanic students scored below Basic. On the same metric, 27% of White and 32% of Asian students scored below Basic, 56% of students receiving free and reduced lunches scored below Basic, 78% of students with disabilities scored below Basic, and 86% of English language learners scored below Basic (NAEP, 2011). Table 2 summarizes NAEP achievement scores for the study state in the school years of 2009 and 2011, showing achievement differences between girls and boys, students by ethnicities, English language

learners, students with disabilities, and students of poverty (receiving free and reduced lunches).

Table 2

NAEP Achievement Scores for the Study State 2009 and 2011 (NCES, 2012)

Group	Year	Below Basic	Basic	Proficient	Advanced
Nation	2011	36	64	31	2
	2009	38	62	29	1
State	2011	43	57	23	1
	2009	46	54	20	1
Boys	2011	45	55	21	1
	2009	39	61	28	1
Girls	2011	47	53	18	–
	2009	48	52	19	–
Hispanic	2011	57	43	12	–
	2009	61	39	10	–
Black	2011	69	31	7	–
	2009	66	34	9	–
White	2011	27	73	35	1
	2009	32	68	30	1
Asian	2011	32	68	31	1
	2009	37	63	26	1
English Language Learners	2011	86	1	2	–
	2009	95	5	–	–
Students of Poverty	2011	56	44	14	–
	2009	61	39	9	–
Students with Disabilities	2011	78	22	6	–
	2009	79	21	6	–

These data show a trend of under–achievement in science by eighth grade for Hispanic and Black students, English language learners, students of poverty, and students with disabilities. These data support a premise that many students are not experiencing science such that they are able to achieve or exceed national averages and that this lack of engagement is evidenced in middle school. It is evident from the state NAEP data that language, poverty, and ethnicity impact achievement but it is not clear whether this lack of achievement might also be due to students' lack of interest in different science topics.

International comparisons. International assessments in science demonstrated that some students who succeeded on international achievement measures may not elect to pursue additional science classes or science careers. The United Nations Educational, Scientific and Cultural Organization (UNESCO), (2008) suggested that there was a global problem with the manner in which science and technology classes were organized, designed and taught. Surveys of secondary students revealed a respect for science but a lack of desire to pursue science courses at the high school and later university levels (Schreiner & Sjoberg, 2004). In the study state, 8% of high school students took an Advanced Placement course in science but only 3% of students who actually took an Advanced Placement science test earned a passing score of 3 and higher (Change the Equation, 2011).

American economists cite the emergence of other countries as leaders in the science fields, and the outsourcing of research and development jobs (Osborne & Dillon, 2008) as a possible explanation for the decline in the numbers of American students entering science fields (Mathews, 2011). However, similar challenges are emerging in other developed countries. Surveys of students from countries such as Finland and Japan

revealed a generation of students who succeeded academically in science but no longer pursued careers in science, technology and engineering (Osborne & Dillon, 2008; Sjoberg, 2007). Moreover, some students believed science and technology were a source of world problems (Haste, 2004; Osborne & Dillon, 2008; PISA, 2007; Schreiner & Sjoberg, 2004), which may have increased their hesitancy to engage in science courses and pursue science as a career.

In the U.S., the National Science Education Standards (NSES) (1996) advocated for all students to have the opportunity to participate in the activities of science. As a policy document, the intent of these standards was to introduce students to the community of practice of science as novices, young apprentices, who over multiple years of schooling would build a repertoire of skills common to the scientific community. It was recently acknowledged that parts of the NSES (1996) were enacted as intended, but standards related to practices of scientists, were not nearly as well addressed by teachers as intended by NSES authors (National Research Council, 2011). One possible explanation could be that science educators were not science professionals and lack the experience to provide the authentic activities necessary for students to have legitimate peripheral participation and were in need of better professional development; or equally plausible is that the community of practice of science is different from the community of practice of science education.

Much like the NSES (1996), *A Framework for K–12 Science Education* (NRC, 2011) affirmed that all students must have the opportunity to engage in the practices of science and engineering. The necessary skills for this participation should be introduced in the elementary years, introducing students to the appropriate behaviors and practices

needed to permit them legitimate peripheral participation in the community of practice of science. This skill set is broadly described in the *Framework* document as the "practices of science and engineering" (NRC, 2011) and the ultimate goal of school science is increased student interest in science, increased scientific literacy and increased numbers of students in the science career and college ready pathway.

As the NGSS are completed, science curricula, instruction and science assessments will need to be re–envisioned and revamped to address the integrated nature of the performance expectations (Achieve, Inc., 2011; NRC, 2011). The structure of a science standard in the NGSS will include specific performance expectations, which delineate what students should be able to do with the disciplinary content information. This structure is an effort is to enculturate students to the practices of science and engineering. Each performance expectation will integrate the disciplinary core idea with a unique crosscutting concept and a science and engineering practice. When the NGSS are released, policy makers will have the opportunity to consider how new policies can be written to fully coordinate and articulate science education (DeBoer, 2010; Duschl, Schweingruber, & Shouse, 2007). These policies will influence the types of courses taught, how these courses are taught, and how they are assessed. The findings from this study may propose a model, which informs the direction that policy makers pursue as the implementation of the new science standards reframe K–12 science instruction, curriculum and assessment in novel ways.

Science Education in the Study District. This study proposed to explore both participants' science interests and perceptions of their science education by conducting a survey of tenth grade science students in the study district using the *Relevance of Science*

Education (ROSE) survey. Understanding how students think about science and technology and the choices they make regarding their courses of study and career interests should inform educators, policy makers and stakeholders, and is important to study because 81% of students in the study district graduate with a standard diploma (State Report Card, 2011). Students matriculating with a standard diploma were only required to complete two science classes in their high school experience. This may leave many of the study district's science students unprepared for college or career level expectations. It may also indicate that they do not have the skills to engage in legitimate peripheral participation in the community of practice of science at the university or community college level.

The ROSE survey has been enacted by countries around the world, which surveyed their students as a representative sample of their country. As a school district in an urban center that attracts populations of peoples from across the United States, the students in the study district represent a unique mix of students many of whom may have attended multiple schools. In 2010, the study district reported a transiency rate of 32.5%. The students were mobile and ethnically diverse making them uniquely different from the study populations in previous ROSE surveys.

In 2010, the study district reported a student population of less than one percent Native American, approximately 10% Asian Pacific Islander, 41% Hispanic, 14% African American, and approximately 35% White (Study District, 2010). Approximately, 44% of the study district's students receive free and reduced lunches, 10% are identified as having special needs and approximately 18% have limited English proficiency (Study District, 2010). When Lee and Buxton (2010) described science achievement among

non–mainstream students underserved by science education in the United States, many of the characteristics they highlighted were similar to those of the study district's students.

Demographics of the study district are captured in Table 3. The number of male and female students matches the State demographics of 51.5% male and 48.5% female students. The study district struggles with a high student transiency rate (32.5%) (State Accountability Report, 2010) and the service industry nature of its largest city, which does not have large industries employing scientists, does not often give students an opportunity to have mentors or to envision themselves as working scientists or engineers (Tate, 2008).

Table 3

Study District 2010 – 2011 Demographics (Study State Report Card, 2011)

Ethnicities	State	Study Distrct
American Indian / Alaskan Native	1.2	0.6
Asian	6.0	7.1
Hispanic	38.8	42.1
Black / African American	9.9	12.4
White	38.7	31.8
Pacific Islander	1.1	1.2
Multi–Race	4.3	4.7

Students in the study state are required to pass a high school exit test in science in order to graduate. Table 4 shows 2011 science assessments results by ethnicity for the study district as compared with study state results. Study district science scores were slightly lower than the state study average. Study state science assessment data showed

that district–wide, 62.9% of students met standard on the science exam (State Accountability Report, 2011) but that Hispanic students score 7.3% less than this average and African American students score 13.5% less. White students score 11% higher than the district average. These data support the premise that Hispanic and African American students may be representative of underserved populations of students in science in the study district.

Table 4

2011 Science Assessment Data for the Study State and Study District

(State Report Card, 2011)

Students	State District	Number Enrolled	Achievement Standard			
			% Emergent/ Developing	% Approaches	% Meets	% Exceeds
Total	State	30 004	8.7	20.3	64.3	6.8
	District	21 229	9.7	21.4	62.9	6.0
Male	State	15 346	9.2	17.7	64.1	9.1
	District	10 927	10.4	18.6	62.9	8.1
Female	State	14 657	8.1	23.0	64.5	4.4
	District	10 302	9.0	24.3	63.0	3.8
Native American	State	354	9.5	23.0	64.7	2.9
	District	122	10.8	18.3	69.2	1.7
Asian	State	1 938	5.4	15.3	69.6	9.7
	District	1 599	5.9	15.5	68.9	9.7
Hispanic	State	10 464	13.0	28.6	55.6	2.9
	District	7 946	13.4	28.9	54.9	2.8
African American	State	3 162	17.8	31.2	49.3	1.7
	District	2 951	17.9	31.0	49.4	1.6
White	State	12 451	3.8	12.0	73.4	10.9
	District	7 318	4.0	11.9	73.9	10.2
Pacific Islander	State	343	8.2	17.8	67.5	6.4
	District	292	7.0	17.5	68.0	6.5
Multi–Race	State	1 290	4.0	13.8	73.7	8.0
	District	1 001	4.0	14.3	73.3	7.7

The study state assessment, unlike national and international measures of science achievement, does not gather information regarding students' science content interests,

science course taking interests, or interests in entering science or science related careers. Not knowing this information makes it difficult for teachers, schools, districts and the state to allocate resources to effectively design programs to engage students in science. The ROSE survey might may inform teachers and district leaders about the participants' interests and in turn, influence future design or redesign of science and technology courses especially as the NGSS are developed and states determine whether to adopt them.

The study district adopted a progress model to ensure that students graduate from high school, college and career-ready (Study District Progress Model, 2010). To this end, leadership in the study district is restructuring its science sequencing for secondary high school students to focus on the core sciences of biology, chemistry and physics. Some science electives, which appealed to adolescents, were eliminated or scaled back. Leaders in the study district have decided that a policy of core science classes will better support college and career readiness.

Current high school graduation rates for the study district are shown in Table 5. Approximately 33% of males and 30% of females failed to matriculate in the study district. Further inspection of the data reveals that the graduation rate for Native American students is 8.6% less than the study district average (although they test well in science); the graduation rate for Hispanic students is 8.3% less than the study district average; and the graduation rate for African American students is 10.5% less than the study district average. Failure to matriculate from high school predestines students to profound economic difficulties as adults (Tate, 2008). These particular populations of students are identified as high risk and are seemingly underserved by the study district.

Lee and Buxton (2010) use the term underserved to describe at-risk populations of students. By contrast, Asian students graduate at 14.2% higher than the district average and White students graduate at an average of 8.3% higher than the district average.

Table 5

Graduation Rates Study State vs Study District (Study State Accountability Report, 2010)

Graduation Rates	State	District
% Total # of Students	70.3	68.1
% Male	68.1	66.3
% Female	72.3	70.0
American Indian / Alaskan Native	64.1	59.5
Asian	81.3	82.3
Hispanic	60.3	59.8
Black / African American	57.6	57.6
White	78.4	76.4
Pacific Islander	NA	NA
Multi–Race	NA	NA

Study district specialty schools. The study district has 24 specialized schools several of them with clear STEM (science, technology, engineering and mathematics) curricula and focus. The current national emphasis on STEM education derives from a perceived need to increase the numbers of students in science, engineering and technology and to provide opportunities for students, while in high school, to engage in authentic learning experiences reflective of the real community of practice (NRC, 2011). In these specialized schools, there is a blending of the theoretical with the practical.

Science classes are specially designed to capture a Career and Technical Education (CTE) focus typically situated in project–based learning environments. Many students in these schools are provided with mentors and apprenticeship opportunities through their schools' unique programs. Students are actively engaged in the community of practice through their schools' use of intentional programs and focused themes. With these opportunities, it might be expected that students in specialty schools have greater interests in science and technology.

Previous Studies

With so much attention directed towards student achievement on high stakes tests, it might be useful to survey students about how they perceive their science education and what topics they might find interesting to better support their science studies. DeBoer (2011) argued that state and national assessments do not explain why students were declining to pursue science at higher-grade levels or to pursue STEM careers. His analysis suggested that science curricula have become more similar across the country and the world and further investigation into the decline in student enrollment in science was needed. The study district has not explored how high school students perceive their science education It may have been assumed that with the use of engaging learning materials, access to technology and a focus on scientific inquiry pedagogy that students would perceive science as a way in which to think about problems in their everyday lives and that they would further use their knowledge and skills in science to solve everyday problems; however, there was no evidence to support this assumption. As new national standards are developed, identifying, knowing and understanding student interests can

potentially inform courses design and instructional pedagogy focused on the integrative nature of the NGSS standards to support students as they work as novice scientists.

Summary

This study used a situated learning perspective to explore tenth grade participants' interests in science, and their perceptions of their science and technology education. Data from the 2009 NAEP indicated that science achievement among Hispanic and African American students lagged behind Asian and White students across the nation and also in the study district (Change the Equation, 2011). As populations who may not have experienced consistent science education, it was of importance to explore how Hispanic and African American student participants view science and whether their interest in science is related to their experience in school science.

This study endeavored to articulate participants' interests such that their views could enlighten policies and practices that describe ways in which science and technology education could be designed and taught. This study was timely given that the National Academy of Science was developing a new set of science standards, the NGSS, scheduled for publication in spring 2013. The NGSS, grounded in *A Framework for K–12 Science Education* (National Research Council, 2011), will represent a new reform for science education. The *Framework* (2011) document specifically addressed the need for students to have access to high quality and engaging science education throughout their entire K12 school experience. The *Framework* (2011) proposed that science and engineering practices should be used to invite students to the community of practice of science. As the NGSS continues to be developed, this study examined its drafts to see how coherent the new science standards were with student interests.

The proposed study was situated in a large school district in the southwestern U.S. and explored the interests of its students through the following research questions:

1. What perceptions do students have about themselves and their science classroom and how might these beliefs be influencing their participation in the community of practice of science?
2. Considering a future science classroom where the curriculum is framed by the *Next Generation Science Standards* how might the standards foster students' beliefs and perceptions about science education and their legitimate peripheral participation in the community of practice of science?
3. Based on their school science interests and perspectives, what can be inferred about students' identities as future scientists or STEM field professionals?

Significance of the Study

This study contributed to the existing body of knowledge regarding students' interests in science and student perception of the relevance of their science and technology education to their lives and prospective course and career choices. It offered the potential to provide a model for the study district and impetus for an evaluation of how curriculum documents might be designed and how teacher professional development can be envisioned as the district considers implementation of the NGSS. It may provide opportunities for schools to explore different approaches to the science classroom environment by considering student interests, situated learning perspective and the NGSS. Students have been required by local, state and federal policies to be accountable for their learning by passing high stakes testing in order to earn a high school graduation diploma. Asking students how they perceive their science education can inform their

teachers, district curriculum and assessment developers, educators in the community (informal educators), business leaders and policy makers. Students potentially can become a resource in the decision–making process.

Limitations

Although surveys gather information quickly and from large numbers of participants, they can also be limited by the nature of the items and the scales used in the survey. Participants might not completely understand an item or hesitate when choosing their response on the scale. Interviews with students would have clarified data on their understandings about different science topics of interests and enlightened the researcher's understandings of students' perceptions about their school science experience. The study was also limited by its voluntary nature and policies of the study district which govern how teachers can participate. Although there were teachers interested in participating in the study, their principals did not give them permission. Additionally, some students in the participating classes elected not to take the survey. Their input could have contributed to the overall understandings of study questions.

Conclusion

This study intended to examine students' responses to the ROSE survey and to view their responses using a situated learning perspective. This study was informed by the limited science data available, which were achievement results on state and national assessments. The intent of this study was to deepen the research base about the interests and perspectives of science students in a large urban center, which intended to inform the study district's K–12 science education program and policies, and which could also be

used as a model to support inferences about potential issues with the adoption of the NGSS in the United States.

Chapter 2

Literature Review

The promise of the authors of *A Framework for K–12 Science Education* (NRC, 2012) and the *Next Generation Science Standards* (NGSS) (Achieve, 2012) is science for all students, achieved by (a) increasing the rigor of and pushing science education into the 21st century, (b) improving student achievement in science, and (c) ensuring the next generation of potential scientists and a scientifically literate citizenry. The *Framework* authors promote the theme of science for all by emphasizing the importance of engaging students from the earliest grades in the practices of science and engineering (NRC, 2011). Through these practices, it is expected that students will be able to identify and achieve as apprentice scientists.

It has been suggested that the notion of science for all, which originated with the *National Science Education Standards* (1996), is egalitarian and democratic; however, enacting science for all is far more complex (Barton, 1998; Hogrebe & Tate, 2010). The idea that science literacy was achievable by all children if the proper tools and support were provided within the school system (Barton, 1998) was implicitly understood but not explicitly implemented. As evidenced by the 2011 National Center for Educational Statistics (NCES) studies of student transcripts and course taking characteristics, students historically underserved in science have continued to be underserved. The lack of access to high quality mathematics and sciences classes has been cited as the new civil rights issue of the 21st century (Tate, 2001).

The founding principles of *A Framework for K–12 Science Education* (2011) guide and ground the development of the NGSS (Achieve, 2012). These principles

respect that (a) children are born investigators; (b) science education should be focused on fewer but key foundational ideas and practices; (c) there is a progression to learning, which develops and matures over time; (d) the knowledge and practices of science and engineering are intimately connected; (e) students must be invited to learn science through explicit connections made to their interests and experiences; and (f) science education promotes equity for all children (NRC, 2011).

Eight practices of science and engineering are described in *A Framework for K–12 Science Education* and emanated from our understanding of the work and praxis of scientists and engineers (NRC, 2011). These practices are intended to be reflected and integrated through the core ideas and crosscutting concepts of the NGSS as they are developed (Achieve, 2012). Their inclusion is designed to model the work practiced by scientists in their everyday endeavors (Jan, San & Tan, 2011). The *Framework* authors suggested that students experiencing the practices in this manner will begin to understand, appreciate and identify with the methods and work of scientists from their earliest school activities. The eight practices include:

> (1) Asking questions and defining problems; (2) developing and using models; (3) planning and carrying out investigations; (4) analyzing and interpreting data; (5) using mathematics, information and computer technology, and computational thinking; (6) constructing explanations and designing solutions; (7) engaging in argument from evidence; and (8) obtaining, evaluating and communicating information (NRC, 2011, p. 42).

Implicit in the practices is the notion of the use of scientific discourse or language (Quinn, Lee, & Valdes, 2012), which naturally occurs among scientists but which students struggle to use (Jan et al., 2011).

Using lessons learned from the *National Science Education Standards* (NSES) (NRC, 1996), the *Framework* authors explicitly discussed the importance of equity in science education. Acknowledging that the demographics of students nationwide have been and continue to change (Lee & Buxton, 2010), and that many students have historically been underserved (Tate, 2010), the *Framework* proposed that inequities have arisen in two fundamental areas: "(a) The differences in the opportunity to learn due to inequities in schools and communities; and (b) the lack of inclusiveness in instruction to motivate diverse student populations" (NRC, 2011, p.11.2). To address all of these issues is complex; however, the *Framework* recommended approaching science instruction by recognizing "(a) science learning as a cultural accomplishment, (b) relating youth discourses to scientific discourses, (c) building on prior interest and identity, and (d) leveraging students' cultural funds of knowledge" (NRC, 2011, p.11.2–11.9).

Examination of the science standards for the study state showed that the practices of science and engineering were not encapsulated in these standards, which guided the development of the syllabi documents for the study district. This would seem to indicate that teachers have no leadership in their state or district guiding documents which sets forth the principles for student engagement in their science education as apprentice scientists. This lack of leadership within the science standards to fully incorporate student engagement through their legitimate participation in their science education may be part

of the problem related to the achievement gap and students' declining interests in science education and in the field of science.

This chapter explores situated learning as a theoretical framework and discusses the literature supporting the research questions of this study. It will review literature related to student science interests and identity development in science classrooms and how research is attempting to understand the interplay between student science topic interest and student science identity. This chapter will also examine factors impacting students' interests and perceptions towards science including gender, culture, class, race and ethnicity, access to mentors and some teacher pedagogical strategies.

Theoretical Framework

A situated learning perspective was used as the theoretical framework for this study. Situated learning proposes that learning and knowing is achieved through the processes of co–participation in specific environments or contexts (Allal, 2001; Lave & Wenger, 1991; Sadler, 2009) and, as such, considers how a learner is enculturated into a community of practice through legitimate peripheral participation (Allal, 2001). Situated learning has three essential features: (a) A social and material context; (b) activities and interactions; and (c) participation and identity (Johri & Olds, 2011). From this perspective, learning occurs within a socio–cultural context through problem solving, imitation and engagement in authentic activities (Lave & Wenger, 1991). Socio–cultural contexts recognize that learning is a process that occurs in social settings that involves the individual interacting with her environment, other people and objects. Learning is not simply an accumulation of knowledge, but a transformation of individuals as they move from novice status through legitimate peripheral participation towards full membership in

a community of practice of the experts (Hmelo & Evensen, 2000; Lave & Wenger, 1991). A community of practice is understood to comprise the "individuals who are enacting the tools, both conceptual and physical, used in the community of practice and the cultural norms that guide practice and interactions within the community" (Sadler, 2009, p. 4). The community of practice establishes the contexts and "constrains what learners and other participants can do and come to know" (Sadler, 2009, p. 2) Knowledge is not transmitted from one person to another but is constructed in context (Orgill, 2007).

The assumptions of situated learning can challenge science instruction by emphasizing the role of (a) authentic tasks, which are the basic and ordinary practices that are unique to the community of practice, and which ultimately become the basis of student apprenticeship; (b) anchored instruction, which focuses on the notion of situated context for the consideration of complex and challenging problems to engage students; (c) learning communities and the idea of students and teachers collaborating in the classroom community resulting in distributed expertise; and (d) assessment of the student during the authentic activities noting their level of achievement (Johri & Olds, 2011). This study begins the process of examining students' science interests such that its findings can be used to inform contemporary science instruction using a situated learning perspective and to consider how intentionally designed authentic tasks can be informed by knowing the nature of students' science interest with the intent to continuously and purposefully draw them into the community of science.

Community of practice. Knowing and learning occurs through the novice's engagement in authentic learning activities within a community of practice, through legitimate peripheral participation and results in enculturation (Sadler, 2009). Authentic

learning tasks are the normal and everyday practices unique to the community, and legitimate peripheral participation refers to the inclusion of students as apprentices into the community through their engagement in these normal practices or tasks that should eventually lead to their competency within the community. "The community of practice circumscribes the social and physical environment that provides the context for participation" (Sadler, 2009, p.4). These sustained development cycles within the community of practice and the molding of the novice's identity as a practitioner result in a full understanding of the dynamic nature of the specialty (Lave & Wenger, 1991). Legitimate peripheral participation moves beyond thinking simply about engagement in an activity to a more the dynamic nature of the "learning within the human experience" (Lave & Wenger, 1991, p.121).

The experience of students in school science should naturally lead to development of the characteristic skills and attributes of the community of practice of science with students becoming either legitimate participants or at minimum, knowledgeable participants. Students, throughout their school science experiences, should be engaged in science such that the frame of the activity is designed to allow them to view themselves as budding scientists. Their identities and discourses within the school science community of practice should emulate the community of science as reasonably as possible. Understanding students' interests in science topics and the concept of cognitive apprenticeship can enlighten how instruction and curriculum might better respond to the diversity of students it serves. That all students are apprentices in their learning opens avenues for thinking about the science classroom as a community of science learners. Educators should consider the knowledge and skills that their students bring to the

classroom (Seiler, 2010), and how their skills can best be incorporated, strengthened and appreciated by the science classroom community. The social aspect of situated learning can best utilize the practices of science, which include collaborative and communication skills in its processes. Students can learn that science is iterative, continuously studying new and old questions through examination of scientific evidence.

Situated learning and school science. A situated learning perspective can be used to frame the experience of students who, through curiosity and observation, and with appropriate and supportive guidance of their teacher, develop scientific skills through legitimate peripheral participation. As students mature, they acquire the skills needed to engage in complex science and engineering practices defined by *A Framework for K–12 Science Education* (NRC, 2011). These practices include asking questions; proposing, designing and carrying out investigations; interpreting data and generating explanations using scientific evidence; using mathematical and computational tools; and communicating results using appropriate models, representations and argumentation. Each of these practices can be considered as authentic entry points for student apprentices. These practices are referred to as conceptual tools of a domain (Brown, Collins & Duguid, 1989) and their use is practiced through the authentic tasks of the community. The novice learner is enculturated to the community of practice through cognitive apprenticeship with the goal of developing competency within the community (Allal, 2001; Brown et al., 1989; Bell, Lewestein, Shouse, & Feder, 2009). Authentic activities refer to those activities developed by a community of practice outside of school and which can be integrated into the classroom environment (Allal, 2001).

As students' interests in and perspectives about science are considered, situated learning perspective contributes to a deeper understanding of the classroom community. By describing learning as a collaborative and cogenerated process, a comparison can be made to a highly structured science classroom where students have limited opportunities to (a) participate in the practices of science (Elster, 2007; Johri & Olds, 2011), (b) learn to use the conceptual tools of scientists, or (c) engage in an apprenticeship atmosphere. A situated learning perspective speaks to the classroom environment, the design of the curriculum, and the learning tasks (Sadler, 2009). It speaks to equity for all students as they learn science content which is important and meaningful to them (Wink, 2010), become student members of the community of science, and consider themselves as full practitioners through career choice (Johri & Olds, 2011). It frames a discussion about the place of students' interest in contemporary science education (Wink, 2010).

In a classroom designed around situated learning, one might expect to see the essential characteristics of cognitive apprenticeship evident as students engage in scientific practices and activities unique to the community of science such as initiating scientific questions; engaging in dialectic conversations; which focuses on students reasoning through active dialogue with their teacher (the expert) and fellow students about their study questions; designing methods in which to gather their evidence; manipulating materials; collecting data as supporting evidence for their ideas; developing models as ways in which to interpret and analyze their data; and thinking about how to articulate and communicate their understandings. The sense–making activities in which students engage are iterative and science language–intensive. Using the practices of

scientists as they vest in the community of practice "demands and affords rich student discourse" (Quinn et al., 2012, p.3).

Science identity. In the science classroom, students develop an identity, their ability to view themselves as youthful apprentice scientists, (Sadler, 2009; Yonezawa, Jones & Joselowsky, 2009) that allows them to practice the language of the community of science, express their values within the norms of the community, use the conventions of scientific discourse (Quinn et al., 2012), and become proficient in the skills of a scientist (UNESCO, 2009). The science classroom viewed this way is dynamic and robust; and dialog or scientific conversation, one of the conceptual tools of the community of practice of science, is a critical component. It has its own culture, which encompasses the sub–cultures of its participants. It is guided by rigorous and equitable standards (Wink, 2010).

The notion of students having a science voice that is a way in which to contribute and collaborate in their science class may not be well understood by teachers who may embrace a "stereotyped notion of what counts as scientific reasoning and privilege a subset of sense–making practices at the expense of others" (Bell et al., 2009, p.40). All students, but especially students from underserved populations, show competencies and abilities which may not be recognized or valued in the school setting (Burton, 1998; Hogrebe & Tate, 2010; Lee & Fradd, 1998). A situated learning perspective can encourage students to use their funds of knowledge, that is the knowledge they have learned from their families and culture, (NRC, 2011; Seiler, 2001) as a way to give them legitimate peripheral participation in the community of practice of science. In the next section of this chapter, the focus shifts to exploring at-risk student populations in science

education and reviews several research studies which have examined factors influencing at-risk students' interest in science.

Student Interest in Science

This study argues that many high school students do not have the opportunity to fully engage in the science and engineering practices as defined by *A Framework for K–12 Science Education* (2010) nor do they engage in scientific discourse with the result that they become disillusioned with their science education, and by default, disenfranchised from the community of practice of science. As a result of their experiences with school science, many students, especially underserved populations of students, lose interest in scientific topics and find their science classes boring and lacking in importance to their lives (Settlage & Meadows, 2002; Sjoberg & Schreiner, 2004).

Studies have shown that students in elementary and early middle school have high topic interest in science especially by age 10 (Organization for Economic Cooperation and Development [OECD], 2006; Simpson & Oliver, 1990), and express career interest by age 14 (Dewitt, Archer, Osborne, Dillon, Willis & Wong, 2010) but this interest sharply begins to decline in high school (Osborne, Simon & Collins, 2003; Simpson & Oliver, 1990; Sjoberg & Schreiner, 2005) especially for individual content subjects such as physics (Lindahl, 2003; Williams, Stanisstreet, Spall, Boyes & Dickson, 2003) and chemistry (Osborne et al., 2003). Among students, boys have more favorable attitudes towards science than girls (George, 2006; Simpson & Oliver, 1990; Sjoberg & Schreiner, 2004). Students believe science is a difficult subject (Sjoberg & Schreiner, 2004; UNESCO, 2009), and because they have a lack of information about 21st century science, students retain antiquated and biased images of working scientists and engineers (OCED,

2006). This research informed this study by suggesting that very young students were capable and sophisticated thinkers who have early science topic interests which may be overlooked by science education.

Some studies have examined the *science for all* ideal through the lens of students who traditionally have been disenfranchised by the education system: children of poverty and non–mainstream students. Many students in poverty find science to be boring, abstract and disconnected from their life experiences (Basu & Barton, 2005). Barton (1998) argued that even when resources were equivalent, children in poverty still received a different education than their peers. Students in poverty have not had experiences similar to their peers and their school struggles often were attributed to cognitive and developmental problems (Barton, 1998), which fault the students rather than the system. Many non–mainstream students came to school already believing that they were incapable of engaging in science and that science was not a subject with which they could identify (Barton, 1998; Basu & Barton, 2005). For such students, science was a body of knowledge, a set of facts to be memorized, and not an experience that invited them to participate. Barton (1998) argued "scientific knowledge is constructed through social acts in which the individual, who is at the same time a social being, interacts in a distinctive way with society and culture to create something" (p. 530). Seiler (2010) suggested that schools serving populations of students in poverty might consider an instructional design that addressed and valued students' experiences, and worked to support and cultivate a science identity in the science classroom. These findings supported a situated learning perspective that learning is a social enterprise that can capitalize on the experiences students bring to school rather than creating an atmosphere

of isolation. It further supported the idea that student apprenticeship in science should begin at the earliest ages in order to develop confidence in the science practices and skills that can result in strong student identities as budding scientists.

The ideas elementary children who were homeless had about their community's pollution problems were investigated by Barton (1998). Their experiences were used to develop authentic scientific contexts in which the children could ask questions, study and research explanations, and make reasonable proposals to solve the problems. Barton emphasized the importance for science teachers to consider their students' context as part of their instructional design. Her findings point to a continued tension between the students' home identity and school science identity as aspiring scientists. She suggested a shift in learning occurred when students learned to become "critical negotiators of, and participants in, subject realities" (Barton, 1998, p. 538). An important aspect of this study was the researcher's inclusion of the students in making choices about the science in which they engaged. Students were interviewed about their lives in a homeless shelter and revealed that most disturbing to them was the pollution in the local neighborhood. Based on this interview, Barton (1998) was able to galvanize her students' interests and directed them towards understanding how they could solve the pollution problems in their neighborhood. She empowered the students, developed their identities as young scientists and blended the science content within a very real context for the students.

In a different study with middle school students in an afterschool program, Basu and Barton (2005) analyzed how three low-income students' interests in science might be sustained as opposed to short-term interest cultivated during brief classroom projects. In a critical ethnography, Basu and Barton explored "how engagement is related to whether

science activates students' "funds of knowledge" —their interests, experiences, and beliefs" (p.469). Building on their previous study, the researchers' findings indicated that students' engagement in science was sustained (a) when they participated in authentic and not fake science problems (Basu & Barton, 2005) which related to both their funds of knowledge and also their future career aspirations (Basu & Barton, 2005); (b) when the science lessons were connected to the social nature of the collaborative processes of science; and (c) when the science activity was practical and useful. Usefulness included activities that fostered students' abilities to exert control in their personal lives and made their lives easier (Basu & Barton, 2005), or if the activity connected to sports or outside interests, or if the activity allowed them to solve problems, either personal or community.

This research informed the current study by pointing to the importance of contextualizing the science content such that it can be attainable by students, especially English language learners, students with special needs, and students with different cultural backgrounds. Grounding the science content in practical, everyday experiences can make the science important and by assigning student roles within a group specifically addresses legitimate peripheral participation in the community of practice of science.

Student science interests and career choices. In a series of research study reviews that related students' race, ethnicity and gender to choice of science career, Lee and Buxton (2010) identified three predictors of students' choice of study in college: (a) Expressed interest in science or mathematics during the first two years of high school; (b) the number of actual math and sciences courses taken; and (c) parental involvement during the students' school years. In surveys of students, other predictors of science career interest emerged: (a) Encouragement by counselors and teachers; (b) afterschool

science–related opportunities and activities; (c) self–image; (d) student interests in science careers; (e) parental support; (f) perceptions about the relevance of their science and mathematics classes; and (g) students' conceptions of their abilities. Lee and Buxton (2010) suggested a need for research data that can be disaggregated by the different demographic sub–groups represented in the country. "Making decisions based on collapsed data that do not adequately consider the unique needs of students from diverse backgrounds runs the risk of further disadvantaging the very students that such interventions are at least nominally proposed to help" (Lee & Buxton, 2010, p. 43).

Lee and Buxton (2010) reviewed several research studies that compared students' home culture related to their beliefs about school science and science. Findings indicated that all students but especially students from non–mainstream populations had strong beliefs in the metaphysical and supernatural and often attributed weather phenomena to societal ills such as divorce, drug–use or fighting (Lee & Buxton, 2010). In a separate review of literature on student identity, Lee and Buxton (2010) found, as did Basu and Barton (2005), that student identities continued to be shaped by the classroom community of practice of the science. When activities fostered group interactions and each member of the group had a role to play, students were able to capitalize on the variety of opportunities afforded. This finding informed this study. Students may not have solidified a healthy science identity during their K12 science education, and they may not have had the opportunity to have a role in their science class that naturally developed their science identities. A lack of fledgling identities as youthful scientists may have impacted students' science interests later in their schooling.

Seiler (2011), researching urban, low income African American students, observed that when students were highly engaged in science activities, they employed not only funds of knowledge but also repertoires of practice: ways of speaking, methods of problem solving and sense–making and "shared cultural referents" (Seiler, 2011, p. 5). Seiler (2001) asserted that African American students' cultural backgrounds differed significantly from White culture in a nuanced way not appreciated in school. "An African American belief in the influence of nonmaterial, vital forces in people's everyday lives contrast with the Euro–American faith in material, mechanistic forces. African American culture values affect, whereas, White culture values reason" (Seiler, 2001, p. 1005). Science educators may not be aware that their African American students' home and cultural identities might lead them to disengage from the traditional ways in which science is typically presented in school. African American students may struggle to develop an identity in science. Seiler's observation, if shared with teachers, could enable instruction to emphasize how the science content could be used to study a local problem of importance to the students and which complements the cultural experiences of the students. Learning would naturally be situated for the students.

In her study, Seiler (2011) observed that curriculum materials provided by a publisher acted as a gate–keeper for student involvement in science, impacting both student achievement and interest. When the curriculum was modified to take advantage of students' funds of knowledge and repertoires of practice, the new materials fostered student voice and their power to act (Seiler, 2011). Students were involved in the everyday planning of their science classes, which resulted in the emergence of several

best practices: students (a) connected science with their lives, (b) posed their own questions, (c) had choice, and (d) had voice.

Student Identity Development

In situated learning, the development of an identity associated with the community of practice is achieved through authentic activities enacted through legitimate peripheral participation. School communities foster identities, which are immediately evident to students. Some examples can include the smart student or the class clown. Outside school, students may recognize the neighborhood bully as a classic identity. Yet, in the classroom, there are identities that develop and may only exist for the length of the class period. "Science identity is the sense of who students are, what they believe they are capable of, and what they want to do and become in regard to science" (Aschbacher, Li & Roth, 2009). Students participate in multiple communities of practice throughout their day and manage to navigate the norms and practices of each of these communities. Over time, identities change and develop in part due to the influences of other factors including parental support, peer influence, self–efficacy (Aschbacher et al., 2009).

In a study of 33 high school sophomores who expressed interest in science careers in the tenth grade, results found that 45% of the students lost interest in science by the twelth grade (Aschbacher et al., 2009). These students were termed the lost potentials by the researchers and although they represented all of the participating high schools in the study, many of the lost potentials were of mid to low socio–economic status. No one ethnic group dominated the lost potentials although no Asian students were in this group. More boys than girls were represented in the lost potentials. In the tenth grade, many of the lost potentials identified strongly with science and expressed high interests in

pursuing careers in science. They cited role models and positive experiences they had with related activities (Aschbacher et al., 2009). In a follow–up interview, the lost potentials cited bad experiences in their eleventh and twelfth grade science classes, a lack of mentorship, and a lack of out–of–school experiences in science as reasons for not pursuing science careers. Lost potentials indicated that other role models and mentors in non–science subjects had played a pivotal role in their decision (Aschbacher et al., 2009). Lost potentials expressed frustration at not having more rigorous science classes to take and poor teaching as contributing factors in their decision to not pursue science careers.

Students who persevered and chose to pursue science careers in college were dubbed the SEM (science, engineering and math) persisters. The high SEM persisters in this study came from the same two high schools, had more Asian students, and more girls interested in pursuing science careers. The SEM persisters cited good academic achievement, extracurricular experiences, and were more likely to be in the mid to high socio–economic status (Aschbacher et al., 2009). The low SEM persisters came from one study high school, which included four students who were enrolled in the school's Health Academy. Low SEM persisters had lower grades than their peers, attended fewer science classes, and avoided difficult science classes. By twelfth grade low SEM persisters were discouraged by their science classes and sought to pursue technical degrees at the local community college. It was observed that low SEM persisters attended schools that did not offer advanced placement courses and experienced many substitute teachers. They did not identify themselves as scientists or that they were capable of becoming scientists (Aschbacher et al., 2009). African American and Hispanic students in this study reported

that they felt that their teachers, counselors and administrators held lower expectations for them than their Asian or White peers.

The overall finding of the study was that students who felt that they had support from multiple sources, for example, their parents, their church groups or interested adults, were more likely to strongly identify as potential scientists and were more likely to indicate interest in pursuing careers in science. Students "were buoyed by perceived strong and aligned support for their science identities at home, at school, and in extracurricular activities" (Aschbacher et al., 2009, p. 578). This finding informed this study. If students experienced support for their science interests from multiple communities of practice, their science identities, which were fragile and potentially transitory, began to solidify. Activities that interest participants both in and out of school should support their fledgling science identity.

In a recent study on physics identity and gender, Hazari, Sonnert, Sadler, and Shanahan (2010) proposed four factors influence students' identity in physics: (a) The level of interest students expressed in physics topics; (b) "whether they feel competent in their ability to understand physics; (c) if they feel that performing physics tasks are within their capability; and (d) how much recognition they feel with regards to physics" (Hazari et al., 2010, p. 983). Two important findings emerged from this study. In regards to gender differences, it was noted in the literature that girls and boys had significant differences in their perceived interests in various scientific topics (Sjoberg & Schreiner, 2004). It has long been assumed that girls needed better role models and female science teachers, yet in this study, such examples of role models, female science teachers, or guest speakers had no influence on female physics identity. The results showed that

students responded positively to male and female science teachers who were "caring, challenging, engaged, passionate, fair, and/or linked to the actual practice of science in some concrete way" (Hazari et al., 2010, p. 997). A second significant finding suggested that female students perceived less contextual and conceptual connections with the real world phenomena than their male peers. These were areas that the researchers suggested for further study in order to encourage girls to identify with physics (Hazari et al., 2010).

This finding is important to this study because, if aptly interpreted, content alone will not necessarily support students' science topic interests or relate to the development of their science identities. How science standards and curriculum syllabi objectives are written indicate whether a teacher can interpret a context for appropriately designing a science lesson with the end result of engendering students' sustained interests while addressing the standards.

Mentorships. Other research reviews, which typify a situated learning perspective, are those in which students are able to engage in mentorships with scientists or graduate students, or work in laboratories alongside scientists as part of an extra–curricular activity outside the normal school day (Sadler, Burgin, McKinney, & Ponjuan, 2009). Sadler et al. (2009) conducted a review of articles published between 1968 and 2009 which examined high school science apprenticeships. Such opportunities for students to engage in authentic science activities were reported as research conducted with their science teachers participating in ongoing projects established by scientists. Examples include Global Learning and Observations to Benefit the Environment (GLOBE) and Forest Watch (Sadler et al., 2009). Although the numbers of studies on mentorships for secondary science students was small, it was found that students

broadened their interests in the types of science careers specifically with a shift away from medicine (Sadler et al., 2009), and they developed more realistic ideas about the work that scientists do. Equally encouraging was a finding that students' content knowledge statistically improved after laboratory apprenticeships (Sadler et al., 2009) as did their confidence in their abilities to engage in science activities.

In a small study of an apprenticeship research program for secondary science students, researchers observed that students' conceptual knowledge increased as a result of their apprenticeship as did their ability to generate sophisticated questions and explanations (Charney, Hmelo–Silver, Soer, Neigeborn, Coletta & Nemeroff, 2007). Researchers observed that students moved from absolutist beliefs towards more tentative and deeper ideas about science. The results demonstrated the strength of having scientist mentors for adolescent students; and further, students were capable of engaging in the dialectic practices of scientists in the atmosphere of engagement in real research problems (Charney et al., 2007). Students responded positively to coaching by the scientists. The results of this study were promising; however, the study was limited by its small sample size and short duration. The finding that students improved their dialectic practice provided an example of how students can successfully be invited to the community of practice of science through legitimate peripheral participation.

The role of mentorship has been identified as a critical component to sustaining student interests in science topics, yet it is not realistic to expect all students to have mentors. The incorporation of class projects in which students collect or interpret data that is relayed to a scientist is an alternative with possibilities that should continue to be explored most especially for a school system such as the study district, which does not

have high numbers of science related industries in the surrounding community. Students and teachers in the study district are pressed to find mentors in the local community of science. As a consequence, students may be unaware that opportunities exist in the science field for career avenues that interest them.

Thus far research related to students' interests and identity development has been discussed. It is difficult to separate the two constructs of interests and identity. Interests influence identity formation and identity development is influenced by caring, challenging teachers, rich and rigorous science opportunities, both in and out of school, and friends and parents (Hazari et al., 2010; Simpson & Oliver, 1990). Identity evolves and science identities are fragile influenced by both extrinsic and intrinsic factors (Hazari et al., 2010).

The next section shifts in focus to research about student perceptions of science and science education and how their perceptions may be influencing choices they make about course taking and career selection.

Student Perceptions about Science and Science Education

Scientific literacy emerged as a major theme in science education in the post Sputnik era (Bybee, 1997; Holbrook & Rannikmae, 2009; Laugksch, 2000; Roberts, 2007; Sadler & Zeidler, 2009). Scientists and educators alike were concerned that the Sputnik era reforms were focused on the content of science, which was presented so abstractly that students were identifying science as too difficult a discipline and choosing not to continue their studies (Fowler, 1984; Yao, 1985). Presently, students continue to perceive science as a difficult discipline and are not electing to pursue science studies and careers (Dewitt, Archer, Osborne, Dillon, Willis & Wong, 2010; Hogrebe & Tate, 2010;

Swarat, Ortony, & Revelle, 2012; Yager & Yager, 1985). In a study by Jidesjo et al. (2009), the researchers suggested that students did not seem to comprehend how science was evident in their everyday experiences, and that this lack of understanding had potential implications for their future participation as citizens.

In describing scientific literacy, the *National Science Education Standards* (NSES) (1996) stated that students should be able to "ask, find, or determine answers to questions derived from curiosity about everyday experiences" (NSES, 1996, p.22). Bennett, Lubben, and Hograth (2006) defined scientific literacy as the "knowledge, understanding, and skills young people need to develop in order to think and act appropriately, on scientific matters that may affect their lives and the lives of other members of the local, national, and global communities of which they are a part" (p.348). Scientific literacy places an intentional focus on students and the everyday science a student as a responsible citizen encounter (Jidesjo, Oscarsson, Karlsson, & Stromdahl, 2009; UNESCO, 2009).

In order to become scientifically literate, science students must have the opportunity to engage in activities that support the acquisition of science language, knowledge, practices and understandings (Hogrebe & Tate, 2010) specifically, "learning to observe, predict, analyze, summarize and present information in a variety of formats" (Lee & Fradd, 1998, p.14). These skills are the conceptual tools of the community of practice of science. This understanding of scientific literacy underpins the situated learning perspective. Students' cumulative experiences and cognitive apprenticeship in school science should naturally develop the expertise and skills of scientific literacy. Jidesjo et al. (2009) proposed that curriculum could cultivate opportunities to expand

students' scientific literacy by balancing students' perceived impression that science education was a necessary pre–training for college with the "shaping of relevant learning environments" (Jidesjo et al., 2009, p. 224).

Interest and attitude toward science. Understanding what researchers mean by interest and attitude can be elusive. Elster (2006) differentiated between individual and situational interest. Individual interest developed slowly and "comprises subject knowledge and values and is regarded as a lasting preference for a certain thing or activity" (Elster, 2006, p.5). It could be considered to be a characteristic of a person and could be known as topic, individual or personal interest (Lavonen, Gedrovics, Byman, Meisalo, Juuti, & Uitto, 2008). A student expressing interest in science wanted to learn about natural phenomena and engage in the science practices (Lavonen et al., 2008). Situational interest occurred spontaneously and was typically short term (Elster, 2006) often dependent upon the situation or the characteristics of the learning environment (Lavonen et al., 2008). Situational interest could be "spontaneous, fleeting and shared among individuals. At school, it was aroused as a function of the interestingness of an object, like content, context or an activity" (Lavonen et al., 2008, p.88). Situational interest could be dependent on teacher characteristics or pedagogical practices. Interest could also be thought of as having two valences described as feeling–related and value–related (Lavonen et al., 2008). In feeling–related valence, students experienced feelings associated with enjoyment or involvement, while in value–related valence, students experienced feelings associated with the "attribution of personal significance to an object or activity" (Lavonen et al., 2008, p.88). It was thought that situational interest could develop into individual interest when both valences were present (Lavonen et al., 2008).

Interest in being engaged in one's science studies is certainly a goal of school science. This type of interest fosters persistence and motivation, but it is equally important for school science to introduce, develop, and foster emergent student interests (George, 2006; Jidesjo et al., 2009; Swarat et al., 2012). Waning student interests in science education impacts the numbers of future scientists (Osborne et al. 2003). In a survey conducted with high school students around the world, students in more than twenty countries responded negatively to the question "I like school science more than other subjects" yet conversely, hold positive attitudes about the importance of science to society (Sjoberg, 2005).

Osborne et al. (2003) described attitudes as the "feelings, beliefs, and values held about an object that may be the enterprise of science, school science, the impact of science or scientists themselves" (p.1053). Jidesjo et al. (2006) stated that attitude towards science was reflective of the content of science, while "a scientific attitude refers to open–mindedness, honesty and critical thinking" (p.214). Because attitude was not easily separated from context and influence, Osborne et al. (2009) suggested that some studies on students' attitudes might only provide a superficial understanding of how students actually viewed science and science education, and that better methodology was needed to explore students' attitudes.

Osborne (2007) suggested that the science education community viewed science knowledge as predicated by discoveries made over the past two hundred years while students understood scientific knowledge "as residing in the objects and ideas that surround them" (p.178). Osborne (2007) asserted that there was a growing chasm between science, as it presented to students in school, and science as the community

practices it in the 21st century. This lack of connection in school science becomes a contributor to the decline in student interests in, and attitudes and dispositions towards science (Osborne, 2007; Osborne, Simon & Collins, 2003). Other researchers (Swarat et al., 2012) supported this view. Krajcik, Czerniak, and Berger (2003) suggested that students have innate interests in science, which erode as a result of their school science experiences. Students reported high interest when (a) the subject topics related to their personal everyday experiences, (b) the class activities were cognitively engaging, and (c) they were socially involved (Swarat et al., 2012). This finding supported the focus of this study. An informed discussion on future development of science classes and on policy decisions made by school system administrators can be fostered when students' science topic interests are identified and understood.

Studies of students' attitudes toward science. Five studies are reviewed each analyzing student attitudes towards science differently and each supporting and expanding on the other's findings. The *Relevance of Science Education* (ROSE) survey is the first study reviewed and a summary of its findings are presented. The current study used the ROSE survey. "ROSE is an international comparative research project meant to shed light on factors of importance to the learning of science and technology, as perceived by the learners" (Sjoberg, 2010). Researchers and research institutions have collaborated to develop "theoretical perspectives, research instruments, data collection and analysis" (Sjoberg, 2010). The distinguishing factor about the ROSE study was that the researchers collected survey results from over 40,000 students in more than forty countries providing a comprehensive collection of student perspectives about science and science education. The second study was a longitudinal study, conducted from 1980

through 1990, of factors affecting students' attitudes and interests towards science. Researchers followed students from their early middle school years through high school. Study three reported on survey results from a comparison study of student interests and attitudes among students in physics and biology classes. Study four surveyed over 500 middle school students in a mid–western city in the U.S. to determine which factors—learning goals, content or activity—most influenced students' interests. Study five was conducted by the Girl Scout Research Institute and surveyed over 800 high school girls about their interests in STEM careers. The distinguishing aspect of the Girl Scout study was that the researchers differentiated the student participants by ethnicity.

Relevance of Science Education (ROSE) survey.

This study used the *Relevance of Science Education* (ROSE) survey to examine students' attitudes and perceptions towards science education. In 2002, Schreiner and Sjoberg developed the *Relevance of Science Education* (ROSE) questionnaire to explore the perspectives of students from around the world about the relevance of their science and technology education. The ROSE questionnaire emerged from work Sjoberg (2002) completed on the *Science and Scientists* (SAS) study, which explored students' ideas about science and scientists. The SAS study included over 9,000 thirteen-year-old students from around the world. This section describes the ROSE survey, its structure and organization, how it has been used, and how the results open new research avenues.

Schreiner and Sjoberg (2004) used the SAS survey as a foundation for the development of the ROSE survey. ROSE was designed for students around the age of fifteen who are enrolled in high school science classes.

> The purpose of the ROSE study is to provide empirical evidence and to stimulate theoretical discussions about priorities and alternatives in science and technology education. The hope is that such data, seen from the perspective of the learners, may provide important input to an informed debate on how to improve the relevance, attractiveness and the quality of science and technology education so that it can meet the hopes and aspirations of the learners in a diverse world. (Schreiner & Sjoberg, 2004, p.5)

With over 200 items, ROSE was developed to query students' attitudes and interests on different categories of topics which include: (a) "What I want to learn about, (b) my future job, (c) me and environmental challenges, (d) my science classes, (e) my opinions about science and technology, and (f) my out–of–school experiences. ROSE items are written as short statements followed by a four point Likert–style scale, for example: I think that the science I learn at school will be helpful in my everyday life (Disagree – Agree).

Schreiner and Sjoberg (2004) noted that students in more economically developed countries agreed that science and technology are important for society but girls tended to be more ambivalent towards science than boys. Students from wealthier countries did not agree that school science had opened their eyes to career opportunities, and they did not aspire to become scientists. In contrast, students from poorer or developing nations reported high interest in careers in technology and science. Students found school science interesting but not when compared with other subjects. Students expressed high interest in topics directly related to their health and well–being and less interest in topics such as light and energy. One important inference made by the researchers was that the way in

which school science was presented to students was often in competition with television, movies, museums, etc. (Schreiner & Sjoberg, 2004; Jidesjo et al., 2009).

Findings from the many countries who participated in the ROSE survey corroborated and extend the research on student attitudes by examining different study questions. For example, Ogawa and Shimode, (2004) used the ROSE survey to test an analytical framework, which differentiated students based on loving school science versus loving other subjects. Ogawa and Shimode (2004) then separated their students into four groups based on the categories, *no interest in science* and *interest in science*. The researchers concluded that in Japan efforts to identify root causes of student negative attitudes towards science and technology needed further exploration (Ogawa & Shimode, 2004).

Three research studies, which used ROSE guide the design of this study: namely that of Elster (2007), Jidesjo et al. (2009), and Lavonen et al. (2008). Elster (2007) focused her study on the topic interests of German and Austrian students in the natural sciences by examining the relationship between content and context, the topic interest differences between boys and girls, and how students' science topic interests changed during a 10 year period when a previous international survey had been conducted. Elster (2007) found that students were most interested in space exploration and biological/health topics. Least interesting for most students were topics including botany, geology, technology and energy. Girls expressed more interest in biology/health topics while boys' interests included electricity, chemistry, energy and technology. Elster's study focused on the topic interests of boys and girls and compared two countries and

differs from this study, which endeavors to explore boys and girls within their ethnic identities.

Lavonen et al. (2008) used the ROSE instrument; however, their study focus was on developing a way to examine correlations between students' motivations towards science career characteristics, gender, nationality, and interestingness of school science. The study was similar to Elster's (2007) in that students from two different countries were surveyed: Finland and Latvia. Findings showed that there was a small correlation between school science interestingness and four categories of ROSE items that were grouped and named by the researchers. They titled these categories Personal Meaningful, Innovation, Nature, and Social orientations (Lavonen et al., 2008). The researchers concluded that the way in which school science is presented does not provide students with insights into how scientists and engineers really work, and they suggest that teaching methodologies be developed to enable students to see how the knowledge and skills that they acquire through school science can be transferrable to careers (Lavonen et al. 2008).

The final study reported by Jidesjo et al. (2009) was similar to the previous two studies; however, the researchers compared the mean scores of Swedish students with their choices for upper secondary study programs, which included health care vocational, industrial and engineering vocational, social science, and science and technology programs. Findings from this study showed that students overall did not feel that school science had made them better critical thinkers nor had it raised their curiosity about things that science cannot explain. There were significant differences between girls and boys in their science topic interests. Issues facing contemporary society are critical, but "students do not seem to perceive the relevance of science and technology to these

issues" (Jidesjo et al., 2009, p. 224). Further, the researchers noted that students planning to pursue science careers held significantly different opinions about science than their peers who are not interested in science careers. The researchers speculated that student data indicated that students were more interested in learning about today's science rather than about historical science. Finally, the authors indicated that further research was needed concerning teacher variables that might be impacting students' perceptions and interests towards science.

Researchers who used the ROSE survey did so with students to represent the population of their country. The students were listed as citizen participants representing their country. As a result, international comparisons could be made. For example, researchers were able to compare Finnish students with British students (Sjoberg & Schreiner, 2004) and determined that students had similar interests, and that girls and boys had differences in their science topics of interests. The researchers did not disaggregate their participants by their ethnic origins. It is interesting to note that in the United States, national and state assessments always report student results by multiple factors including gender, age, socio–economic status, and by ethnicity. In this study, the ROSE survey was used to explore students' science interests as an entire group of high school second year science students, as girls and boys, and by ethnicity. Whether students' interests vary by ethnicity was an unanswered question in many research studies about students' science education perspectives (Lee & Buxton, 2010). In this regard, this study was different from previous ROSE studies completed by Sjoberg and Schreiner (2004), Ogawa and Shimode (2004), Jidesjo et al., (2009), Lavonen et al., (2008), and

Elster (2007). In these studies, the researchers examined students' perceptions and interest either as a whole group representing their countries or separated by gender.

American society is not homogeneous and students are confronted with and navigate multiple cultures daily (Ghosh et al., 2007). The school district in this study included a diversity of students from multiple backgrounds with multiple ethno–linguistic identities, which could be categorized into Hispanic, Asian, White, African America and Multi–race. Within these categories were multiple subgroups, all which have their own languages and cultures. Understanding the complexity of the communities of practice in which these students navigate is challenging; however, the focus of this study was on the community of practice of science, which offered its own language and culture. The community of practice of science can be used to present students with opportunities to cross borders, so to speak, from their home languages and cultures to the science culture (Aikenhead, 1996; Lee & Fradd, 1998). Yet, it was not known how students perceived their science education and whether they might see themselves as aspiring scientists or how their science classrooms might be redesigned to capitalize on their developing identities to preserve their presence in science classrooms.

Long term survey of student attitudes toward science. In a 10-year, longitudinal study completed by Simpson and Oliver (1990), the researchers found that students' attitudes towards science correlated with their friends' attitudes, but this relationship began to decline after ninth grade. Confirmed by other studies (Osborne et al., 2003), these researchers found that motivation to study science and attitudes towards science declined from the middle grades through tenth grade. A significant finding cited by the researchers was that among average achieving students, who are not in the upper

or lower achievement quartiles, there was a sharp decline in their attitude and achievement when compared with more advanced and lower achieving students (Simpson & Oliver, 1990). The researchers speculated that teachers spent more time with the higher and lower achieving students, and less attention was dedicated to middle achievers. Another finding was that the role of the classroom experience, more so than family or outside factors, most influenced students' attitudes towards science. Student self–efficacy in science, which was the students' beliefs in their own competencies and abilities to reach and attain goals (Bandura, 1994), and achievement strongly influenced their attitudes and whether they continued to study science in high school. A finding was that if students have positive achievement and feelings towards science in their earliest required science classes (middle school), then they have a greater commitment towards science, which influenced their lifelong attitudes (Simpson & Oliver, 1990). This study potentially questioned the role of earlier science education experiences that students had prior to high school and whether these experiences were designed to foster students' budding interests or contributed to a decline in their participation.

Survey of students' attitudes toward biology and physics. In a survey conducted with tenth grade science students, findings showed that students identified physics as both boring and difficult when compared with biology (Williams et al., 2003). Girls identified physics as boring because they perceived it as being too easy and not connected with their lives (Williams et al., 2003). Boys reported physics as being boring or uninteresting because they perceived the activities to be repetitive and not practical. Students reported that biology was more practical and important to their everyday lives. Further, the study results indicate that students did not perceive the application of physics

as a way to solve societal problems such as environmental problems; however, students reported high interest in topics about space (Williams et al., 2003). The researchers suggested that physics teachers could examine their lessons for applicability and importance to students as one way in which to promote interest in physics. This study supported previous research by demonstrating how important it was for all science teachers and curriculum designers to consider situating science content in a context that has importance to the everyday lives of students. This study also focused attention on standards and objectives that guide the development of syllabi and curriculum. By not integrating science and engineering practices which are the conceptual tools of the community of practice of science into the guiding documents, there is a loss of context for the students and teachers, which unnecessarily abstracts the science content thereby limiting legitimate peripheral participation.

Survey of middle school students' attitudes toward science. Swarat et al. (2012) conducted a study of more than 500 middle school science students near a U.S. mid–western city. The student participants were ethnically diverse and there were approximately equal numbers of boys and girls. The researchers wanted to know whether students' interest was most closely related to subject content, the goals of the lesson or the designed activity. Their results demonstrated that the type and design of the science activity most influenced student interest while the instructional goal and content had very little influence. Context was highly important for engaging students in science instruction. The researchers suggested that in future work they would like to separate the questionnaire items into content, activity and learning goal so that the students would

have to identify with each component individually (Swarat et al., 2012) with the intent to provide a clearer understanding of students' interests.

Survey of Girl Scout students toward science. In a study completed by the Girl Scout Research Institute (GSRI) (2012), researchers surveyed 852 high school girls from across the United States. The study examined girls who expressed interest in science, technology, mathematics and engineering (STEM) fields as well as girls who were not interested in STEM fields. Findings showed that over 74% of the girls surveyed were interested in STEM fields. Girls identified themselves as interested in the "process of learning, asking questions, and problem solving" (Modi, Schoenberg, & Salmond, 2012, p.2). Almost 92% of the STEM identified girls not only considered themselves to be both smart enough to pursue a STEM career, but also thought they were smarter than other girls. An important finding of this study was that 66% of the girls interested in STEM fields had some exposure to STEM experiences. Additionally, the study showed that just because girls expressed interest in STEM fields, only 13% were passionate about having a STEM career. The study concluded that negative stereotypes hold girls back from pursuing STEM fields.

Among Hispanic, Caucasian and African American girls, several differences were found. In response to the following interest item, "How things work," 83% of Hispanic girls expressed interest, 82% of African American girls responded with high interest, and 75% of Caucasian girls responded with high interest. GSRI researchers suggested that the next step in working with girls is to help them learn how to turn their positive perspectives about science, engineering, technology and mathematics into serious career choices (Modi et al., 2012). An interesting feature of the Girl Scout Research Institute

study was the intentional focus on ethnicity differences of the participants. Many research studies focused on gender differences in students' attitudes and perceptions, and less on examining attitude differences among ethnic groups. Although much research has been done on achievement differences of students of different ethnicities (Tate, 2010, Lee & Buxton, 2010), how students of varying ethnicities differ in their attitudes towards science is less understood. This national study of high school Girl Scout students has broadened understandings of ethnicity and informs this study by clarifying students' interests and perspectives in STEM topics and careers.

Summary

In this chapter, situated learning was used to frame a review of research on student science interests and identity. Situated learning focuses on three areas: social and material context; activities and interactions; and participation and identity (Johri & Olds, 2011). Each review emphasized one or more of these three features. *A Framework for K—12 Science Education (*NRC, 2011) incorporated the practices of science and engineering, which incorporates all three of the situated learning features. The *Framework* also integrated the science disciplinary ideas with the crosscutting concepts. The NGSS as they are written from the *Framework* will challenge science educators to frame their instruction from a situated learning perspective. As the new standards are implemented, focus on better understanding how student identity is fostered within the learning environment will require understanding the interplay between science topic interest and student science identity. The research reviewed in this chapter has highlighted several findings including: students lose interest in science education (a) when they find it to be overly fact driven (Basu & Barton, 2005; Sadler, 2009); (b) not

practical (Basu & Barton, 2005); (c) too far removed from their home cultures (Seiler, 2001; Lee & Buxton, 2010); and (d) beyond their perceived capabilities (Hazari et al., 2010; Lee & Buxton, 2010).

Several of the research articles focused on gender differences, students of color, urban youth, and students of poverty and how each of these different populations of student experienced school science. Several studies suggested that socio–economic differences may disenfranchise students by preventing their legitimate peripheral participation in science (Basu & Barton, 2005; Seiler, 2001); that students of poverty were not encumbered by learning disabilities, but more that teachers and administrators did not fully understand the everyday experiences of these students (Barton, 1998).

Another study found that gender differences played a role in both students' interests and in their identity development (Hazari et al., 2010). Girls and boys alike responded best to male and female teachers, who offered encouragement, were challenging and fair, and had some legitimate experience in the science field (Hazari et al., 2009). Students showed high interest in science topics when they were engaged in (a) collaborative and authentic group work that assigned roles; (b) group work which students found important and connected to their everyday lives and which required collaboration and discussion; (c) encouragement from their teachers, parents and friends, which supported their self–confidence and identity development (Aschbacher et al., 2009; Lee & Buxton, 2010); (d) had participated in real science research whether in a professional laboratory or in the classroom (Sadler et al., 2009); and (e) had mentors (Charney et al., 2007).

Concerns about the differences in student achievement in science, also referred to as the achievement gap, of students of different ethnicities were frequently cited as serious problems (Lee & Buxton, 2010; National Assessment of Education Progress, 2009). Additional concerns focused on "how ethnicity, race, gender, and social class mediate the school's role in student learning, the construction of youth identity and development" (Ghosh, Mickelson & Anyon, 2007, p. 275). Schreiner and Sjoberg (2004) asserted that adolescent students grappled to create their identities, but struggled as they were continuously barraged with societal images of what their bodies should like, or the dangers that lurk in their environments some resulting from industrial, technological and scientific endeavors.

Science educators face multiple problems including a lack of funding, over–packed classrooms, lack of attention from policy makers, and also a student perception that science and technology are no longer connected to their lives (Schreiner & Sjoberg, 2004). Many researchers perceived this lack of connectedness as a very serious threat to the future of democracies (DeBoer, 2000). Because school districts have adopted rigorous science curricula to prepare students for college, many students have had limited or no experiences with the way that science can influence personal, community, country and global issues. Science becomes an activity, which invites only a select few to participate. Students understand and respect the importance of science but do not feel competent to pursue the discipline (Schreiner & Sjoberg, 2004). On the other hand, districts may adopt curricula designed around current and contextualized issues that may not provide students with enough science content knowledge to actually understand the problems that face them.

Areas of future research may include conducting studies which provide better data that can be disaggregated by ethnic sub–groups (Lee & Buxton, 2010); understanding the importance of role models for students in identity development; and the importance of context and content in science instruction. This study endeavored to continue to explore the area of students' perceptions and interests towards science education, their emerging identities as apprentice scientists and how the NGSS may frame science classrooms of the future. The study's findings may inform and potentially stand as a model for teachers, curriculum developers and policy makers.

Chapter 3

Methodology

This chapter outlines the methodology used in the current study. Previous research has focused on the importance and purpose of science education and corresponding student achievement on high stakes assessments (DeBoer, 2010) yet, if an important goal of schooling is a successful science education that produces scientifically literate students and students who choose science, technology and engineering careers (STEM), then it is also important to understand the perceptions and topics of interests to the learners as well as their achievement on standardized metrics because interests have been related to students' persistence in science studies and choices of STEM-related careers (Beier & Rittmayer, 2008; DeBoer, 2000; Schreiner & Sjoberg, 2004).

Purpose

The purpose of this study was to use the *Relevance of Science Education* (ROSE) questionnaire to survey 15 and 16 year old science students in a large school district in the southwestern U.S. about their ideas concerning their science education in order to address the following research questions:

1. What perceptions do students have about themselves and their science classroom and how might these beliefs be influencing their participation in the community of practice of science?
2. Considering a future science classroom where the curriculum is framed by the *Next Generation Science Standards* how might the standards foster students' beliefs and perceptions about science education and their legitimate peripheral participation in the community of practice of science?

3. Based on their school science interests and perspectives, what can be inferred about students' identities as future scientists or STEM field professionals?

Using a situated learning perspective, this study endeavored to explore participants' ideas about their science classes and postulate how their ideas might be influencing their participation within the science community of practice. With the *Next Generation Science Standards* (NGSS) under development, this study sought to understand how students' ideas, perspectives and science topics of interest might influence the ways in which science education could be designed to maximize student legitimate peripheral participation, possibly serving as a model for the study district and other districts striving to implement the NGSS when they are published and adopted. Finally, this study endeavored to explore how students' identities as apprentice scientists may influence their identities as future scientists or STEM field professionals.

Appropriateness of research design. The selected research design used survey methodology to explore participants' topic interests and perceptions about science and technology and their science education. The *Relevance of Science Education* (ROSE) was selected as the research instrument (Sjoberg & Schreiner, 2004). ROSE was originally envisioned as a country–wide survey but has been used by researchers with varied groups of students. Using the ROSE, data is collected on students' attitudes and interest in specific topics in science and technology rather than on the broad areas as measured in metrics such as *Programme for International Student Assessment* (PISA) (Bybee & McCrae, 2011).

Findings from this study were used to characterize and profile the topic interests of boys and girls and representing the ethnic diversity of the study district. The ROSE

questionnaire has been used for over 10 years with 40,000 students (Schreiner & Sjoberg, 2004). Students in their second year science classes were the target population because they most closely resembled their peers from around the world who took the ROSE survey.

Policy decisions, such as the implementation of the *Next Generation Science Standards* (NGSS), influence assessment, instruction, and curriculum and are likely to have impacts on the relevance of science and technology to students (Achieve, 2012). Students' motivations, interests and perceptions of science impact their course enrollment and career selection (Osborne & Dillon, 2007; Sjoberg & Schreiner, 2002) yet students are rarely queried for their input. Contemporary students seem to be signaling their opinions by not enrolling in elective science classes, and not pursuing careers in science (Jenkins, 2006; Osborne, 2003). Why students are not enrolling in more science courses represents a compelling area of query. While student interviews would provide a rich tapestry of data to develop understandings around students' perspectives on science education, a survey, even with its limitations, can access a larger pool of students and provide an overall sense of student perspectives quickly and uniformly.

The ROSE questionnaire. The goals of the ROSE questionnaire coincide with the philosophical underpinnings of situated learning. As students endeavor to identify themselves in the community of practice of science, the mainstream science education community must find natural entry points for the student apprentices and foster their identity as scientists by providing them with legitimate peripheral participation. *A Framework for K—12 Science Education* (NRC, 2011) stresses as one of its principles the importance of considering students' interests in science as part of their invitation to

the community of science. Understanding how students view themselves in relation to their science education experience can become a strategy for science education. The survey results can help describe a science classroom based on the NGSS and address potential changes to pedagogical practice that incorporates the idea of student apprenticeship into the community of science education by the authentic incorporation of the practices of science and engineering.

The questionnaire (see Appendix M), "consists of closed, pre–structured questions, which, by their format, offer the respondents fixed alternative responses" (Schreiner & Sjoberg, 2004, p.35). In this study, the questionnaire contained 225 items, divided into subsections. The item categories included:

1. "What I want to learn about" (105 items);
2. "My future job" (26 items);
3. "My out–of–school" interests (61 items);
4. "My science classes" (16 items);
5. "My opinions about science and technology" (16 items); and one item that asked
6. How many books are there in your home (Schreiner & Sjoberg, 2004), which was an effort to determine if socioeconomic status might impact students' interests. The same strategy was employed in the *Programme for International Student Assessment* (PISA) survey of student interests.

All of the survey responses were in a four level format of *not interested*, *somewhat interested*, *interested* and *very interested* (small to large) or *strongly disagree*, *disagree*, *agree*, and *strongly agree*. Sjoberg and Schreiner (2004) chose this format

instead of a standard Likert–style scale to avoid students selecting a middle value (for example, selecting 3 on a scale of 1 – 5) and thus requiring them to make a selection (Schreiner & Sjoberg, 2004).

Krosnick (1999) suggested that if a survey used numbers, then the numbers should be described with a verbal classification to avoid conflicting meanings. The ROSE questionnaire avoided these potential problems by not giving respondents a numeric scale. Krosnick (1999) also pointed out that scales with endpoints labeled with words rather than numbers improved validity and reliability of an instrument because they clarified the meaning of the scale. He reported that researchers found unanticipated results from using numeric scales since respondents sometimes interpreted the numbers to have meanings.

The choice to not include a middle point or a no opinion option is supported by research. Krosnick (1999) suggested that by requiring respondents to make a choice, problems associated with respondent fatigue and waning motivation on a survey were avoided. He suggested that researchers found that respondents uncertain about making a response selection may actually select a no opinion option if they were unclear about the topic, felt that by making a selection they might appear uninformed, or they were becoming tired with the survey. The ROSE questionnaire required students to make a choice, thus avoiding any potential ambiguity.

Content and context themes. The primary content and context areas investigated by ROSE are listed in Table 6 and Table 7 along with the abbreviations (codes) used to classify each theme. These codes were used to help further discriminate among the questionnaire responses. This was the same coding used in the ROSE survey and was

used in this study for consistency in comparability. Schreiner (2006) stated that the contexts were developed based on their "reading of sociological theories about late modern youth culture; review of research in science education; the *Student as Scientist* (SAS) instrument (Sjoberg, 2002); preliminary studies with Norwegian students and teachers, and ROSE partners in other countries" (Schreiner, 2006, p.92).

Table 6

ROSE Content Themes (Schreiner & Sjoberg, 2004, p.54–5)

Content	Code	Number of Items
Astrophysics, Universe	U	12
Earth, Geo–science	G	10
Human Biology	H	23
Botany, Plants	P	7
Zoology, Animals	A	6
Chemicals	C	11
Light, colors, radiation	L	7
Sounds	S	5
Energy and electricity	E	6
Technology	T	5

Table 7

ROSE Context Themes (Sjboerg & Schreiner, 2004, p. 54 – 5)

Context	Code	Number of Items
Environmental Protection	W	8
Practical use, everyday relevance	R	9
Hullabaloo, spectacular phenomena, horror	Z	8
Health	Q	12
Fitness	F	7
Issues of particular relevance for youth	Y	7
Mystery, philosophy, wonder, quasi–science, belief–oriented	M	13
Beauty, aesthetical aspects	B	5
Science, Technology, and Society; Nature of Science	X	5

While some items included in the questionnaire might be construed as being controversial, the inclusion of these items was essential to understanding fringe topic areas of interest to students, such as ghosts, horoscopes, and mind–reading (Schreiner and Sjoberg, 2004). The authors did not infer that such content areas should be included in normal science curricula but rather that they related to topic interests of 21st century students and bear understanding since students frequently confused science and pseudo–science presented in popular media (Schreiner & Sjoberg, 2004). Other context themes may seem unusual such as the hullabaloo theme that Sjoberg and Schreiner (2004) used to categorize topics that are not usual everyday events.

Items added to survey. Some very basic modifications were made to the ROSE survey for its implementation in this study. Consideration was given to adding other categories, which were unique to the study district but the intent of this survey was not so much to compare schools or classes within the study district but to see how participants' collective ideas and understandings compared to each other and also, on some items, to their peers from around the world. As such, only two new items were added at the beginning of the survey. Students were asked to identify the school they attend and their ethnicity. Geographically, the study district was very large including rural, suburban and urban schools. The question about ethnicity reflected whether the surveyed population and its results were representative of the demographics of the study district. The question about the school provided information about the type of school participating which helped determine whether it was suburban, rural, urban, or a specialty school.

Population

The purpose of the ROSE survey was to investigate ideas, interests, perspectives and concerns of 15 and 16 year old students across the world (Schreiner & Sjoberg, 2004). This study surveyed an approximately equivalent group of science students in the study district representing rural, suburban and urban District schools including specialty high schools. These students have taken mandatory science classes since middle school, which used science instructional materials selected for their inquiry content and because the instructional materials met the science standards mandated by the state.

Sample Selection

The Director of Science for the study district supported this study and provided the project with a list of science department coordinators. A letter of invitation (see

Appendix B) was sent to the science department coordinators explaining the study and requesting the coordinators to extend the invitation to their tenth grade science teachers.

Most schools used computer scheduling programs and students were assigned to classes randomly. By inviting students in tenth grade science classes, it was expected that there would be relatively equal numbers of boys and girls participating; however, in actuality, there were not equal numbers: 299 girls and 215 boys who participated in the survey. Efforts were made to have representative participation from rural, urban and suburban schools reflective of the diversity of the study district; however, urban schools were under–represented. Additional, personal letters were sent to science coordinators inviting and encouraging their science students to engage in the study so that the sample would be representative. However, the survey was voluntary and complete representation from all student groups was not achieved.

This study aimed to create student profiles by gender and ethnicity to compare students' mean scores on science topics of interest, career interests and ideas about their science classes. This was different from the approach used in the international studies of students using the ROSE survey, which reported its student participants by country of origin. The study district in this project was ethnically diverse and it was thought that there may differences in participants' science topic interests and perceptions due to socio–cultural differences.

Survey Procedures

Letters of invitation (see Appendix B) to participate in the study were emailed in early spring, 2012 to science department coordinators who forwarded the invitation to their respective science teachers. In the email invitation, teachers had the study

expectations outlined and their responsibilities explained. Teachers were told that the survey would be conducted online requiring students to have access to computers. Participating teachers had to obtain the signature of their principal on the "Principal Acknowledgement Form" before they could be considered as part of the study. Stamped envelopes were sent to interested teachers. When the Principal Acknowledgement Forms were returned, teachers were sent the student assent and parental consent forms, which they printed, distributed and collected from their students. They scheduled time in their computer laboratories.

A volunteer working at the administration building of the study district agreed to handle the collection of the paperwork. When students returned the signed forms, teachers sent them through school district mail to the volunteer who verified that the students had signed their assent forms. The volunteer then emailed the survey link to the participating teachers. The questionnaire was administered online using Zoomerang software. Zoomerang Survey software is an online survey template that allows ubiquitous access to a survey from any computer with Internet access. All students were able to access the survey online and no paper surveys were completed. Teachers did not report any abnormalities or difficulties in using the Zoomerang software.

Data Collection

The survey was launched in early May 2012. The survey link was sent to participating teachers who returned all the required paperwork. Teachers had one month to have their students complete the survey. The teachers from the study district were familiar with the design and operation of the survey platform and reported no difficulties

using it. Zoomerang afforded a consistency in the administration and collection of the students' responses.

Survey Validity and Reliability

Reliability relates to how well an item yields the same result on repeated trials. In the case of the ROSE survey, Sjoberg and Schreiner (2010) stated that reliability was ensured by the large amounts of survey data collected over the past 10 years from 40,000 students across the world; that these many and different students have affirmed each other, and when their responses were compared, they showed consistencies and interesting differences, which in turn generated new questions to examine.

For items, which were grouped within certain sub–themes or contexts, Cronbach's alpha was calculated to determine the internal consistency and to determine whether those items can behave as equivalent measures (Schreiner, 2006).

Internal and external validity. Validity refers to the degree to which a study actually measures the specific concepts intended by the researcher. Internal validity reflects the rigor to which the study was conducted specifically, how well the data were collected; the manner in which measurements were made; and the degree to which the study designers have addressed alternative explanations for causal relationships. External validity determines whether the results of a study can be generalized to a larger population. Construct validity refers to how adequately a test or scale measures a construct or how well a test measures its intended attribute (Henrichsen, Smith, & Baker, 1996). The next sections discuss how internal, external, and construct validity were controlled in this study.

Controlling internal validity. Surveys and questionnaires can be weak on internal validity particularly because descriptors of *agree* and *disagree* or *like* and *dislike* may not measure an individual's true feelings. Findings can be said to be internally invalid when they are impacted by factors other than what was thought to have caused them, or because the data interpretation by the researcher is not clearly evidenced (Henrichsen, Smith, & Baker, 1996). Factors potentially impacting internal validity of study may include variability of the subjects, subject population size, data collection time, instrument sensitivity, student maturation or attrition (Henrichsen, Smith, & Baker, 1996).

This study controlled factors impacting internal validity including subject variability by sampling science students in the study district who were in their second year of science and were approximately fifteen or sixteen years of age (comparable age of typical ROSE participants). The size of the sample population was calculated and monitored during the study to ensure minimum numbers of participants. The participants self–reported their ethnicities, and although every effort was made to match the demographics of the study district, this did not occur.

All student participants received the questionnaire delivered in the same standardized format through the use of the online survey format. Teachers were given notice to secure computers. As such, it was hoped that data collection would be completed in a 2 to 3 week time frame. Monitoring survey launch time minimized maturation issues. Concerns regarding participants tiring during the survey were controlled. A small trial run with the survey was conducted with a volunteer student to ascertain the length of time needed for a typical student to complete the survey. The

ROSE survey has been used for 10 years with over 40,000 students, and has been calibrated, adjusted and piloted three times by Sjoberg and Schreiner (2010). Students completed their assent forms and understood the nature of the study. Their participation was completely voluntary and they could elect to exit the survey at any time.

Controlling external validity. External validity concerns can impact how a study's findings can be generalized to a larger population. This study was not testing a specific hypothesis and endeavored to explore students' responses by comparing them with their peers in the study district. Factors impacting external validity in this study could include: characteristics of the population, subject selection, researcher interactions, research environment effects, researcher or experimenter factors, data collection methodology, and time effects (Henrichsen, Smith, & Baker, 1996). The population characteristics were held stable by inviting second science year students. Students completed the survey only once, which minimized sensitivity to the instrument and fatigue over time. Students completing the survey did not interact with the experimenter. Data collection occurred during their regularly scheduled science class time and over 515 students participated representing rural, suburban, urban and specialty schools. Further, by using an online format, data collection was held consistent.

Controlling Construct Validity. Individual items on the ROSE survey queried students' attitudes, concerns and interests. Schreiner (2006) explained that construct validity of the ROSE questionnaire was determined from exploratory data analysis of items in ROSE. Resulting construct groups emerged from this analysis. The content and context labels used in ROSE developed from both exploratory factor analysis and reliability analysis, combined with the initial ideas behind the items including Sjoberg

and Schreiner's conceptual understanding of the items. For the purpose of this study, content and context labels used in ROSE were employed. Items identified within a theme were tested for reliability using Cronbach's alpha.

Research Questions

In this section the research questions are separated, variables identified and the survey items supporting the research questions listed. Methods of analysis are listed alongside the survey items.

Table 8

Research Questions and Analysis Summary

Research Questions	Variable	Survey Items	Analysis
What perceptions do students have about themselves and their science classroom and how might these beliefs be influencing their participation in the community of practice of science?	Beliefs, Perceptions	Data source: Questions from ROSE sections A, C, E ("What I want to learn about and me and my science class")	Descriptive statistics; *t* test analysis
Considering a future science classroom where the curriculum is framed by the *Next Generation Science Standards* how might the standards foster students' beliefs and perceptions about science education and their legitimate peripheral participation in the community of practice of science?	Classroom characteristics	Questions from ROSE sections A, C and E	Interest scores, *p* values, state content standards, district syllabi objectives, draft NGSS standards
Based on their school science interests and perspectives, what can be inferred about students' identities as future scientists or STEM field professionals?	Content interest; career interest	Questions from ROSE about future course selection and career interest.	Descriptive statistics, *t* test comparisons

Research Question 1

What perceptions do students have about themselves and their science classroom and how might these beliefs be influencing their participation in the community of practice of science?

Data sources supporting Research Question 1 in the ROSE survey were located in sections A, C and E, which were titled, "What I want to learn about." Students were

instructed to read the brief items with the direction to respond to the following prompt: "How interested are you in learning about the following" (Schreiner & Sjoberg, 2004, p.54)? The means and standard deviation of the student responses to the items were calculated using both Excel 2007 and Statistical Package for Social Science (SPSS), Version 19 analysis software. The means for the responses for boys and girls, and for boys and girls factored by ethnicity were compared using independent two–tailed *t* test analysis. In order to develop a student profile, items were clustered around content and context themes identified in Tables 6 and 7. Reliability analyses were calculated and reported. A grand mean for these thematic areas were calculated and compared across gender and ethnicity.

Research Question 2

> Considering a future science classroom where the curriculum is framed by the *Next Generation Science Standards* how might the standards foster students' beliefs and perceptions about science education and their legitimate peripheral participation in the community of practice of science?

A Framework for K–12 Science Education (NRC, 2011) was used as the comparison document supporting this research question as the *Next Generation Science Standards* (NGSS) (Achieve, 2012) are still being written. *A Framework for K–12 Science Education* (NRC, 2011) defined the practices of science and engineering, identified the core disciplinary content ideas, and identified the crosscutting concepts which will be integrated by the NGSS performance expectations. The *Framework* formed the basis for understanding and designing student legitimate peripheral participation in their science classes. Analysis of students' interests in and outside school compared with

the science and engineering practices defined by the *Framework* and described by the performance expectations crafted through the NGSS provided an image of what students should be doing in a future science classroom. This framing was compared with current syllabi from the study district to predict how a future science classroom can be envisioned.

Research Question 3

Based on their school science interests and perspectives, what can be inferred about students' identities as future scientists or STEM field professionals?

Survey results from ROSE Section B, *exploring my future job*, were used to analyze this question. Students mean scores for individual and clustered items were determined and compared using t–test analysis.

Study Timeline

Table 9 lists the timeline used for conducting this survey including dates for Institutional Review Board (IRB) approval; identification and invitation of teachers; conducting the survey; collecting, analyzing and reporting the data.

Table 9

Study Timeline

Begin Date	End Date	Task
10/15/11	10/30/11	Prepared survey in electronic format using Zoomerang software.
1/3/12	2/5/12	Prepared and submitted materials for UNLV Institutional Review Board.
02/5/12	2/15/12	Prepared and submitted materials to the Director for Science of the study district for internal review and approval. Prepared and submitted materials for the study district Institutional Review Board.
2/5/12	2/15/12	Sent letter of query to science department coordinators explaining the study and asking for Principal Acknowledgement Forms.
4/5/12	4/15/12	Received IRB approval from UNLV and the study district, gathered email addresses of teachers with returned Principal's Acknowledgement Forms. Sent email thanking potential participants, explained timeline and study responsibilities.
4/15/12		Sent email to participating teachers with reminders to schedule computer time for survey questionnaire. The volunteer at the study district gathered student assent forms and parental permission slips.
4/25/12		Sent email reminder and followed through with participating schools to complete paperwork. The volunteer reviewed paperwork and sent out survey link to teachers.
5/01/12	5/30/12	Gathered data. Sent out final reminders and thank you responses. Analyzed student data for demographic consistency. Communicated with advisors.
6/01/12	10/30/12	Analyzed data, wrote survey results and conclusions.

Notifications and Communication

Stage One: Pre–notification email. The science administration for the study district agreed to support this study. The volunteer was approved through the Institutional Review Boards for the University and the study district, and received permission from the Director for Science to assist with this study. As soon as both the University and the study district IRB approvals were received, teachers were invited to participate in the study by email. Information about the questionnaire, its benefits and purpose were explained in the email and copies of the principal acknowledgement, student assent and parental consent forms were included. A copy of this initial email is contained in Appendix B. Czaa and Blair (2005) recommended this strategy. Letters of interest, commitment and principal acknowledgement were received before access to the questionnaire was given. This strategy provided the researcher with an idea of the number of teachers and classes willing to participate and whether additional invitations needed to be initiated. Teachers made copies of the paperwork, sent it home to parents and collected it from students (see Appendix I, Informed Consent Form). Teachers scheduled time in the computer laboratory.

Stage Two: Email with reminder. Teachers received an email notice reminding them that the questionnaire was coming and to plan for it. Teachers were reminded that all paperwork had to be sent to the science project facilitator for review prior to receiving the access link. As soon as the paperwork was received and reviewed, the ROSE Zoomerang link was sent to the teachers with the directions to have their students complete the questionnaire during a class period. Appendix C contains the letter that was

sent to the teachers. Responses to the questionnaire were collected in the Zoomerang survey software platform and analyzed using Excel and SPSS statistical software.

Stage Three: Thank you and reminder email. After the questionnaire was completed, teachers received a thank you note for their participation. The body of this note is contained in Appendix E. All of the information was reiterated in the event that the participating teachers might have deleted the original emails. This strategy was recommended by Dillman (2007).

Stage Four: Follow–up email. Because the timeframe for this survey was short, a follow–up note (see Appendix D) was emailed to teachers to have their students complete the questionnaire. Teachers were asked if they were in need of assistance or if they were experiencing any trouble with the survey link. The deadline for completing the survey was included in the email reminder (Dillman, 2007). The questionnaire information and permission slips were again included in the event that they were lost.

Stage Five: Final email. In the event that teachers were unable to access computers with Internet access and had submitted their required paperwork, a PDF file of the ROSE questionnaire would have been sent to teachers as an option to participating in this project (see Appendix F). Dillman (2007) suggested this strategy as a means to increase teacher participation and response rate. No teachers needed the paper copy of the survey.

Data Analysis

Data analysis for much of the ROSE questionnaire modeled the analysis completed by previous researchers in the international studies. Standard statistics including mean and standard deviation for each of the items was calculated addressing

the research questions described in Table 8. An assumption of a confidence interval of 95% was used as it was in the international study (Schreiner & Sjoberg, 2004). Tables were developed to provide an initial glance through the data. To determine reliability for clusters of items, Cronbach's alpha coefficient was calculated to determine the level of internal consistency (Schreiner, 2006).

Limitations and Advantages

The advantage offered by this study's questionnaire methodology was that participants were surveyed quickly and their ideas and perspectives about their science education and its importance to their lives analyzed. Given the demographics of the study district, it was expected that a variety of participant views would be reflected in the survey responses and a potential student profile developed. Understanding participants' interests could inform teachers, policy–makers and curriculum developers within the district.

The study was limited by the use of survey methodology, which does not develop a deep understanding of participants' topic interests in science as can be developed through an interview approach. It is further limited by the use of the survey with only one school district. An additional constraint is that the survey was administered at the end of the spring semester before final exams and some teachers may not have wished to give up an instructional period. Finally, because the survey structure, as defined by the IRB, relied on students to volunteer to participate as well as to return signed permission slips, some students elected not to participate. The study results were representative of the participants in this study only and cannot be generalized to the population of the study district.

Conclusion

This study used survey methodology to query 515 students enrolled in their second year science class about their science topics of interest, their school science experience and their career interests in science. Teachers administering the survey reported no difficulties or abnormalities. The study was limited by the timing of survey administration, which occurred shortly before the final exam period. It is further limited by the lack of student interviews to support survey data. Future work might include surveying the population of the State and to conduct classroom interviews with students and their teachers complementing and developing a richer description of the study questions.

Chapter 4

Results

The current study used the *Relevance of Science Education* (ROSE) survey (Sjoberg & Schreiner, 2004) to examine topics of interest and perspectives of secondary science students in the study district through the following research questions:

1. What perceptions do students have about themselves and their science classroom and how might these beliefs be influencing their participation in the community of practice of science?
2. Considering a future science classroom where the curriculum is framed by the *Next Generation Science Standards* how might the standards foster students' beliefs and perceptions about science education and their legitimate peripheral participation in the community of practice of science?
3. Based on their school science interests and perspectives, what can be inferred about students' identities as future scientists or STEM field professionals?

Since this study involved minor students and in accordance with the policy of the study district, their involvement was completely voluntary. Participating teachers selected one or more of their science classes to participate in the online survey. Participants were able to access the survey link after they had returned their signed parent permission and student assent forms. Policy of the study district directs principals to give prior permission for any research projects involving their teachers or students. Requests to conduct a research study were sent to high school principals and eight returned the principal acknowledgement form.

The schools from the study district represented one urban, one rural, two career and technical, and four suburban high schools. Data were collected during a 4-week period in late spring of 2012 using Zoomerang survey format. As student participation was voluntary, once engaged in the survey, participants had the option to exit at any time.

In this study, 515 participants including 299 girls and 216 boys took all or parts of the ROSE survey. There were 450 completed surveys. The average age of the participants was 15.5 years and Table 10 shows the breakdown by ethnicity of the participants. Participants self reported their ethnicities by responding to the query: "My background is" followed by a listing of ethnicities as used by the study district (see Table 10). The participants in the study did not represent the percentages of ethnic populations reported by the study district. Because the numbers of respondents did not fully capture the ethnic diversity of the study district, the results describe this group of participants only and cannot be generalized to the larger population of high school students in the study district.

Table 10

Participant Self–report of ethnicity

My background is…	N	Girls	Boys	% of N	District %
American Indian	5	1	4	0.9	0.6
Asian	46	25	21	9	7.1
Hispanic	165	109	56	32	42.1
African American	28	17	11	5	12.4
White	196	106	90	38	31.8
Pacific Islander	19	11	8	4	1.2
Multi–Race	56	30	26	11	4.7

It was anticipated that participants could be enrolled in a variety of classes at the second year level and an item was included in the survey to establish the types of classes in which participants were enrolled. Table 11 shows the breakdown of participant enrollment.

Table 11

Participant Course Enrollment

I am enrolled in…	N	%
Biology	291	56
Chemistry	174	34
Physics	0	0
General Science	53	10

This chapter is organized by the three specific research questions posed in this study. The first section of this chapter reports on topics of scientific interests identified by participants, relates these topic interests to their school science experiences, and postulates on participants' participation in the community of practice of science. Secondly, the study results are used to describe a future classroom framed by the *Next Generation Science Standards* and how student legitimate peripheral participation might be envisioned. The third section examines the study data in terms of student identity development as future scientists.

Analysis of data was conducted using both Excel 2007 and Statistical Package for Social Sciences (SPSS) software, Version 19. Since participants could elect to withdraw from the survey at any time, the number of participants varied within the data. Results were visually examined for missing data sets. Data sets were eliminated, if multiple data points were blank (there were 12 such cases) or if participants failed to identify their gender and ethnicity (there were three cases in which participants did not list gender or ethnicity). Data were first aggregated by gender and then, by ethnicity. Means and standard deviations were obtained for individual survey items. Items, which were identified by content and context themes, were tested for reliability. All had acceptable Cronbach's alpha scores greater than 0.700 except for the content area sound, which had a lower value, $\alpha = 0.607$ (Shultz & Whitney, 2005). These values are listed in Table 12. Students responded to items using a Likert–style scale in which the descriptors were converted to numbers. This scale range included: *not interested* (1), *somewhat interested* (2), *interested* (3), *very interested* (4); or *strongly disagree* (1), *somewhat disagree* (2),

agree (3), *strongly agree* (4). Mean values were computed for the items based on this scale.

Research Question 1: Students' interests and their science classes

Research question 1 asked, "What perceptions do students have about themselves and their science classroom and how might these beliefs be influencing their participation in the community of practice of science?"

Content theme analyses. In order to investigate content topics of interest, survey items were grouped together. The items in the content themes identified in the ROSE project (Schreiner, 2004) were classified, tested for reliability, separated by gender, and the means and standard deviations for boys and girls calculated for each content theme. The same items, now separated by gender and content themes, were further disaggregated by ethnicity to determine if there were differences in topics of interests among the student groups. The 2011 State high school science test results for the study district showed achievement differences among student ethnic groups (Study State Report Card, 2011) and the purpose of separating interest items by ethnicity was to evaluate whether students of different ethnicities had different levels of science topic interest. Table 12 shows the content themes with the mean values for boys and girls and Cronbach's alpha for each content area.

Table 12

Content Means by Gender

Content Theme	Cronbach's α	Girls			Boys		
		n	*M*	*SD*	n	*M*	*SD*
Astrophysics, universe	0.896	292	2.55	0.99	209	2.94	0.96
Earth, geo–science	0.811	289	2.22	0.93	220	2.32	0.96
Zoology, animals	0.798	289	2.55	0.98	220	2.59	1.00
Plants, botany	0.855	285	1.97	0.92	204	2.17	0.97
Chemistry	0.784	289	2.12	0.93	213	2.53	0.91
Light, colors, radiation	0.793	289	2.10	0.95	209	2.51	0.97
Sound	0.607	273	2.30	0.99	201	2.62	0.99
Energy and electricity	0.849	277	2.08	0.92	206	2.62	0.98
Technology	0.814	279	2.17	0.96	206	2.70	0.96
Human biology	0.946	284	2.71	0.96	208	2.65	0.97

Independent *t*–tests for each content theme mean for girls and boys were computed. The *t*–test results showed that in all content themes, except the content themes of animals, human biology and geology, boys demonstrated higher interests in these scientific topics than girls, $p < 0\ .05$. Table13 lists the calculated *t*–test scores for the mean gender differences among content areas noting statistically significant differences. For the interest areas of universe, the *t*–test results were t (487) = 4.30, $p < 0.001$; chemistry, t (506) = 4.97, $p < 0.001$; light, t (482) = 6.00, $p < 0.001$; energy, t (491) = 6.247, $p < 0.001$; and technology, t (487) = 4.30, $p < 0.001$ showed significant differences between girls and boys. Girls and boys showed statistically significant

differences in the content area of sound, t (472) = 2.83, $p < 0.005$. In the content area of plants, t (487) = 2.32, $p < 0.05$, girls and boys demonstrated a statistically significant difference while no statistical differences in girls' and boys' interest means in the topic content areas of animals, t (507) = 0.25, $p > 0.05$; human biology, t (490) = 0.68, $p > 0.05$ and geology t (496) = 1.17, $p > 0.05$.

Girls and boys demonstrated significant differences in science topics of interests. Boys were significantly more interested in science topics about astrophysics and the universe; chemistry; light, colors and radiation; energy and electricity; and technology, $p < .001$; whereas the science topics of sound had an observed $p < .01$; and plants and botany, $p < .05$. The significant differences between boys and girls interests in these particular science topics showed that a gender gap exists in this group of participants. The gender gap in physical science has been well established in the literature (Sadler et al., 2009). In other similar studies, boys tended to favor physical science topics while girls indicated disinterest. It might be an area of future study to use the ROSE survey with middle school science students to demonstrate whether there are topic interest differences between girls and boys that emerge at younger ages.

Table 13

T–Test Results: Content Theme by Gender

Content Theme	*t*	*df*	*p*	CI	95% CI		*SED*
					LL	*UL*	
Astrophysics, universe	4.30	487	<.001	0.39	–0.57	–0.21	.09
Plants, botany	2.32	487	.02	–0.20	–0.37	–0.03	0.09
Chemistry	4.97	506	<.001	–0.41	–0.57	–0.25	0.08
Light, colors, radiation	3.77	491	<.001	–0.33	–0.50	–0.16	0.09
Sound	2.83	472	.01	–0.26	–0.44	–0.08	0.09
Energy and electricity	6.25	491	<.001	–0.54	–.071	–0.37	0.09
Technology	6.00	482	<.001	–0.53	–0.70	–0.36	0.09
Zoology, animals	0.45	507	.65	–0.04	–0.21	0.13	0.09
Human biology	0.68	490	.50	0.06	0.11	0.23	0.09
Earth, geoscience	1.17	496	1.18	–0.10	–0.27	0.07	0.09

Note. *df* = degrees of freedom; CI = confidence interval; *LL* = lower limit; *UL* = upper limit. *p* values are two–tailed.

Ethnic differences. After analyzing the content topics of interest for girls and boys, the results were disaggregated and analyzed by ethnicity using one–way analysis of variance (ANOVA). Ethnic groups identified by the study district included: African American, Hispanic, Asian, Multi–Race, Pacific Islander and White. The same groupings were used in this study. The ANOVA results for girls are reported in Table 14 and for boys the results are listed in Table 15. The analysis of variance for each of the content

areas showed that the effect of ethnicity on student interest was not statistically significant, $p > 0.05$.

Although there were differences in the topic interests means between different ethnic groups of participants, there were no statistically significant differences among groups. This indicates that ethnicity is not a factor in participants' science topic interests. Participants had similar interests and similar topics that they did not find interesting. It may be that further studies are needed to confirm this finding because the survey was voluntary and interested students elected to participate. It may also be that in terms of science topic interests, ethnicity was not as great a factor as gender was.

Table 14

ANOVA Results for Topics of Interest: Girls by Ethnicity

Girls	*n*	*SS*	*df*	*MS*	*F*	*p*
Universe	292	6.71	(5, 296)	1.34	1.28	.27
Technology	279	3.55	(5, 273)	.71	.74	.60
Energy	277	2.51	(5, 271)	.50	.57	.72
Sound	273	2.53	(5, 267)	.51	.50	.78
Light	289	.55	(5, 283)	.11	.12	.99
Chemistry	289	1.39	(5, 283)	.28	.31	.91
Plants	285	1.96	(5, 279)	.39	.45	.82
Animals	289	4.33	(5, 283)	.87	.83	.53
Geology	289	3.38	(5, 283)	.68	.75	.06
Human Biology	284	9.96	(5, 278)	1.99	2.06	.07

Note. SS = sum of squares; *df* = degrees of freedom; MS = mean of squares; Findings are significant when $p<.05$.

Table 15

ANOVA Results for Topics of Interest: Boys by Ethnicity

Boys	*n*	*SS*	*df*	*MS*	*F*	*p*
Universe	209	1.70	(5, 203)	.34	.35	.89
Technology	205	4.50	(5, 199)	.90	.89	.49
Energy	206	2.57	(5, 198)	.51	.49	.78
Sound	201	3.87	(5, 195)	.74	.76	.58
Light	209	4.99	(5, 203)	.10	1.06	.38
Chemistry	213	2.51	(5, 213)	.50	.55	.74
Plants	204	2.17	(5, 198)	.43	.47	.80
Animals	220	3.23	(5, 214)	.65	.65	.67
Geology	220	3.14	(5, 214)	.63	.68	.64
Human biology	208	5.13	(5, 202)	1.03	1.13	.35

Note. SS = sum of squares; *df* = degrees of freedom; MS = mean of squares; Findings are significant when $p<.05$.

Context theme analyses. Complementary ROSE items were grouped together and context themes were identified and tested for reliability similar to previous studies (Schreiner, 2004). All context theme groups were tested for reliability and had Cronbach's alpha values greater than 0.700 (Shultz & Whitney, 2005). The means and standard deviations were computed for girls and boys and are presented in Table 16. The context themes showing the greatest gender differences include: science, technology and society (STS), and fitness. Girls exhibited a greater context interest in topics about fitness while boys demonstrated higher context interest (although low) in STS topics. Low interest mean scores in some context themes such as environmental protection, everyday

use and STS issues bear future study given that the curriculum for students during middle school and ninth grade in the study district had a strong emphasis in these areas. By contrast, high context topic interests in quasi–science and non–science topics (mystery), and low interest in STS/nature of science topics may reflect the influence of media on students' perceptions of various topics. Quasi–science may appeal to imagination and fantasy, while science, technology, and society, and nature of science is directed towards school science.

Table 16

Means: Context Themes by Gender

Context Means	Cronbach's α	*Girls*			Boys		
		n	*M*	*SD*	n	*M*	*SD*
Fitness	0.764	285	2.76	1.02	209	2.31	1.00
Mystery, philosophy, wonder, quasi–science, belief–oriented	0.855	277	2.77	1.06	197	2.72	1.09
Beauty, aesthetical aspects	0.840	280	2.20	0.98	202	2.20	.98
Environmental protection	0.900	273	2.32	0.97	203	2.50	.88
Hullabaloo, spectacular phenomena, horror	0.805	282	2.4	1.00	205	2.66	.98
Relevance, everyday use	0.854	273	2.26	0.94	195	2.23	.96
Issues relevant to youth	0.860	274	2.58	1.03	199	2.75	1.03
Science, technology, and society; nature of science	0.817	282	2.06	0.89	213	2.55	.95

Independent *t*–test analyses were conducted for each of the context theme mean values to determine if there were statistically significant differences between girls and

boys. The compilation of the *t*–test results are presented in Table 17. All context themes showed significant statistical differences, $p < 0.05$ except for the categories: relevance and everyday use, beauty, and issues related to youth. The *t*–test results for the context interest areas of fitness, t (492) = 4.89, $p < .001$ demonstrated that girls had higher interests than boys; and similar analyses related to STS show boys having higher interests than girls, t (493) = 5.89, $p < .001$. Girls and boys showed statistically significant differences in the context topic area of mystery with girls demonstrating higher interests than boys, t (472) = 2.60, $p < .005$; and hullabaloo, which are phenomenal events not normally experienced in everyday activities, with boys showing higher interests than girls, t (485) = 2.86, $p < .005$. In the context area of environmental protection, t (474) = 2.08, $p < .05$, girls and boys showed statistical differences with boys demonstrating higher interest. No statistical differences were noted for relevance and everyday use, t (466) = .34, $p > .05$; issues related to youth, t (471) = 1.77, $p > .05$ and beauty, t (480) = .00, $p = 1.0$.

Table 17

T–Test Results of Means Context Theme by Gender

Context Theme	*t*	*df*	*p*	CI	95% CI		*SED*
					LL	*UL*	
Fitness	4.89	492	<.001	0.27	0.63	0.45	0.09
Mystery, philosophy, quasi–science	2.60	472	.01	–0.46	–0.06	–0.26	0.10
Beauty, aesthetical aspects	.00	480	1.00	0.00	–0.18	–0.18	0.09
Environmental protection	2.08	474	.04	0.35	–0.01	–0.18	0.09
Hullabaloo, spectacular phenomena	2.86	485	.004	–0.44	–0.08	–0.26	0.09
Relevance, everyday use	0.34	466	0.74	–0.15	0.20	0.03	0.09
Issues related to youth	1.77	471	0.08	–0.36	0.02	–0.17	0.10
Science, technology and science, Nature of science	5.89	493	<.001	–0.65	–0.33	–0.49	0.08

Note. *df* = degrees of freedom; CI = confidence interval; *LL* = lower limit; *UL* = upper limit. *p* values are two–tailed. Findings are statistically significant at $p<.05$.

Boys and girls alike demonstrated low topic interests in plants and botany, issues concerning STS, beauty, and nature of science, topics about energy and electricity, conceptual chemistry, and technology. It may be that their interests were low because they lacked exposure to and experience with these topics; however, it may also be that they simply did not value these topics as important to their everyday adolescent lives.

Participants expressed their highest interests in topics about the universe and fitness. Higher interests were noted in topics about hullabaloo, which were phenomenal events not normally experienced in everyday activities; animals; topics about the universe; issues specific to adolescents (youth); context topic of fitness. Finally, the topics of greatest student interest concerned the mysterious and unknown, and quasi–science areas. For example, participants were interested in the context mystery of why the stars twinkle but not in the content theme of light. It appeared that their interests were highest when the content and the context were connected and pertinent to their everyday lives such as with the context theme of fitness and content theme of human biology.

Ethnic differences. The means of each ethnic group by gender were compared using independent *t*–test analysis; however, no statistical differences between the mean values were noted, $p > 0.05$. Rather profiles for each ethnic group emerged and are summarized in Table 18. What emerged was a composite of each ethnic group of respondents who participated in this study. Most participants demonstrated little interest in studying plants; and participants frequently placed the thematic topics of everyday use and relevance in low interest categories as were topics concerning energy and electricity, and STS interests.

Boys of all ethnic groups expressed high interest in topics concerning the universe, and boys in most ethnic groups were interested in subjects concerning technology and mystery. African American boys showed high interest in topics related to human biology while Pacific Islander boys showed interests in issues relevant to youth.

Table 18

Ethnicity Profiles Boys: High and Low Interests

Ethnicity/Boys	Highest Interests	Lowest Interests
African American	astrophysics, universe issues relevant to youth human biology	plants, botany technology relevance, everyday topics
Asian	Technology astrophysics, universe mystery	Beauty, aesthetical plants, botany earth, geo–science
Hispanic	astrophysics, universe mystery technology	beauty, aesthetical plants, botany relevance, everyday topics
Multi–race	astrophysics, universe mystery technology	plants, botany beauty, aesthetical relevance, everyday topics
Pacific Islander	astrophysics, universe mystery issues relevant to youth	relevance, everyday topics beauty, aesthetical plants, botany
White	astrophysics, universe mystery technology	plants, botany fitness relevance, everyday topics

Girls had different interests, which are summarized in Table 19. Some variation was observed among the ethnic groups, yet high interests for girls overall were noted in human biology and fitness, and in topics about mystery and issues relevant to youth. Among girls, fewer interests were observed in science, technology, and society, plants and everyday topics.

Table 19

Ethnicity Profiles Girls: High and Low Interests

Ethnicity/Girls	Highest Interests	Lowest Interests
African American	fitness human biology issues relevant to youth	energy and electricity plants, botany science, technology and society
Asian	mystery human biology astrophysics, universe	relevance, everyday topics chemistry plants, botany
Hispanic	mystery fitness human biology	plants, botany relevance, everyday topics science, technology and society
Multi–race	fitness mystery human biology	science, technology and society energy and electricity relevance, everyday topics
Pacific Islander	fitness human biology issues relevant to youth	relevance, everyday topics science, technology and society plants, botany
White	mystery fitness zoology, animals	environmental protection relevance, everyday topics plants, botany

School science experience. There were 16 items which surveyed participants about their school science experience and these were separated into three cases: school science is interesting, school science informs and influences future career choices, and school science is practical and useful. Items grouped into these categories were tested for reliability and had Cronbach's alpha values greater than 0.700 (Shultz & Whitney, 2005). The means and standard deviations were computed and are listed in Table 20.

Table 20

School Science Experience: Means by Gender

Case	Cronbach's α	*Girls*			Boys		
		n	*M*	*SD*	n	*M*	*SD*
School Science is Interesting	0.881	277	2.41	1.07	199	2.60	1.10
School Science Will Influence my Career Choice	0.784	272	2.05	1.08	199	2.39	1.12
School Science is Practical	0.826	242	2.52	1.10	197	2.67	1.11

The means of each case were compared using *t*–test analysis. These results are compiled in Table 21. In the case comparing whether girls and boys thought school science is interesting, t (474) = 1.89, $p > .06$ there is no statistical difference between girls and boys; in the category, "School science will influence my career choice," t (469) = 3.32, $p < .001$, a statistically significant difference is noted between girls and boys. Boys feel more strongly than girls that school science impacts their career choice; and in the category called, "School science is practical," t (437) = 1.42, $p > .05$, no statistical differences between girls and boys are observed.

Table 21

T–Test Summary: School Science Experience by Gender

Case	*t*	*df*	*p*	CI	95% CI		*SED*
					LL	*UL*	
School Science is Interesting	1.89	474	0.06	–0.19	–0.39	0.01	.10
School Science Will Influence my Career Choice	3.32	469	<.001	–0.34	–0.54	–0.14	.10
School Science is Practical	1.42	437	0.16	0.35	–0.1	–0.36	.11

Note. *df* = degrees of freedom; CI = confidence interval; *LL* = lower limit; *UL* = upper limit. *p* values are two–tailed. Findings are statistically significant at $p<.05$.

A one-way analysis of variance (ANOVA) for each of the content areas was computed to determine whether ethnicity had any an effect on student school science experience category. Results listed in Tables 22 and 23 demonstrate that the effect of ethnicity on the category of school science experience was not statistically significant, $p > 0.05$ for girls or boys.

Table 22

ANOVA results: School Science Experience by Ethnicity

Girls	*n*	*SS*	*df*	*MS*	*F*	*p*
School Science is Interesting	277	5.01	(5, 270)	1.00	0.89	0.49
School Science Influences Career Choice	272	2.19	(5, 265)	.44	0.38	0.86
School Science is Practical	242	7.63	(5, 266)	1.51	1.29	0.27

Note. SS = sum of squares; *df* = degree of freedom; *MS* = mean of squares.

Table 23

ANOVA results: School Science is Interesting by Boys/Ethnicity

Boys	n	SS	*df*	MS	F	*p*
School Science is Interesting	199	6.39	(5, 191)	1.28	1.06	0.38
School Science Influences Career Choice	199	5.05	(5, 192)	1.01	0.82	0.54
School Science is Practical	197	3.44	(5, 191)	0.69	0.60	0.70

Note. n varies due to voluntary nature of survey. *SS* = sum of squares; *df* = degree of freedom; *MS* = mean of squares.

School science is interesting. In the category, "School science experience," participants' responses to "School science is interesting" were moderately positive, *M* = 2.60, and relatively similar in means for both gender and ethnicity except for Pacific Islander boys who had a very high positive mean. Their mean score was the exception to the other five ethnic groups and may be a future area of exploration. Girls and boys generally indicated that all students should study science at school, *M* = 2.98 and were reasonably positive about the statement, "School science is interesting," *M* = 2.77. Student response to the items, "I like school science more than other subjects," *M* = 2.10, and "I would like to have as much science as possible at school," *M* = 2.07, were less favorable.

Girls, *M* = 2.51, agreed with the statement, "School science is a difficult subject for me" more often than did boys, *M* = 2.29. While participants identified science as a difficult class, girls and boys also said that science was not hard for them to learn, *M* = 2.52.

School science informs and influences future career choice. The overall mean scores in the second category, "School science informs and influences future career

choice," were low (Girls: 2.08; Boys: 2.5), and showed differences between girls and boys, with boys responding more positively. Overall, girls did not seem to find that school science influences their future career choices, $M = 2.24$, while boys had a more positive response, $M = 2.40$. Both girls, $M = 1.66$, and boys, $M = 1.70$, responded negatively to the statement, "I want to become a scientist." Conflicting responses were observed to the item, "I would like to get a job in technology" with boys responding positively, $M = 2.81$ and girls responding negatively, $M = 1.80$. Two of the participating study schools are career and technical education schools and future work might be to explore how science careers are portrayed in science specialty programs.

School science is useful and practical. Student perceptions were reasonably positive to the category, "School science is useful and practical" (Girls: $M = 2.60$; Boys: $M = 2.75$). Participants responded favorably to the following items, "The things I learn in science at school will be helpful in my everyday life," $M = 2.52$; "School science has shown me the importance of science for our way of living," $M = 2.70$; and "School science has improved my appreciation of nature," $M = 2.68$. Of all the surveyed ethnic groups, African American girls and boys had the highest mean score for the last item listed above, $M = 3.04$.

Summary Results: Research Question 1

The results for content and context themes indicate that although they did express some interest in science topics, participants in this study were mostly indifferent towards science content and their school science experiences. In the category, "School science is interesting," Hispanic, African American and White girls, $M < 2.40$, along with African American and Hispanic boys, $M < 2.45$ had lower mean values than their peers about

science. Especially low mean scores by girls in the category, "School science informs and influences career choices" ($M = 2.05$) seem to reflect a lack of experience and understanding about and with science.

This finding may indicate that participants, especially girls, do not access career information in their science classes, and they do not interact with the science community during high school in a way that fosters their interests in perspective career and study choices. All participants indicated a lack of interest in pursuing a career in science, $M = 1.71$. Students did not see themselves in science careers. Participants in this study may not have seen role models of scientists to whom they can relate. Girls did not see themselves aspiring to careers in technology, yet boys had a rather high mean score for technology especially when compared with the item, "I want to be a scientist."

As observed through their responses, the mean scores on interest for Hispanic participants seem to follow slightly behind their peers, but not enough to be statistically different; however, their mean scores may not completely provide a clear understanding of Hispanic students' interests and need further study. Since no baseline data on students' science topic interests exist, a finding cannot be made. This is also true for African American participants. The number of participants in this study representing the African American population was small and a larger sample might have provided different results.

Research Question 2: Future Classrooms

Research Question 2 asked, "Considering a future science classroom where the curriculum is framed by the *Next Generation Science Standards* how might the standards

foster students' beliefs and perceptions about science education and their legitimate peripheral participation in the community of practice of science?

A Framework for K–12 Science Education. According to *A Framework for K–12 Science Education* (NRC, 2011), students will engage in the practices of scientists and engineers beginning in kindergarten and progressing in sophistication through twelfth grade. The *Framework* authors emphasized that science includes a "commitment to data and evidence as the foundation for developing claims. The argumentation and analysis are essential characteristics of science: Scientists need to be able to examine, review, and evaluate their own knowledge and ideas and critique those of others" (NRC, 2011, p.2–3). This process emanated from the appraisal of "data quality, modeling of theories, development of new testable questions, and modification of theories and models as evidence indicates they are needed" (NRC, 2011, p.2–3). The *Framework* authors stressed that science and engineering were social enterprises and that with collaboration, scientific and engineering knowledge was advanced.

A Framework for K–12 Science Education (NRC, 2011) provided the backdrop for the development of the *Next Generation Science Standards*. Students can be invited to engage in legitimate peripheral participation through carefully crafted standards that emphasize the practices of science and engineering and the crosscutting concepts that unite the main disciplines of science. This integration will lead to the development of new curricula. Such curricula captivate students' curiosities, interests, and willingness to persist in their studies (NRC, 2011). "Students may recognize that science and engineering can contribute to meeting many of the major challenges that confront society

today, such as generating sufficient energy, preventing and treating disease, maintaining supplies of fresh water and food, and addressing climate change" ((NRC, 2011, p.3–1).

A classroom bound by *A Framework for K–12 Science Education* (NRC, 2011) and the NGSS will have to demonstrate the interconnectedness of the practices, the crosscutting concepts and the disciplinary core ideas. Any standards developed from the *Framework* will have to be dynamic enough for students to engage in legitimate peripheral participation.

Research Question 2 Analyses

Selected participants' responses from ROSE were used to analyze Research Question 2 and then compared with its equivalent State Science Standard; the *p*–value for the state science exam item for students in the study district compared with the overall value for the state; the corresponding content objectives from the study district in biology, chemistry, geosciences and integrated biology and chemistry; and finally, a proposed performance expectation from the draft NGSS document (May, 2012). This comparison can lead to an understanding of how legitimate peripheral participation in a Next Generation Science classroom might evolve.

Example 1: Chemical reactions. In this example, the State science content standard asks students to know that "chemical reactions take place at different rates, depending on a variety of factors (i.e. temperature, concentration, surface area, and agitation)" (Study State Science Standards, 2004, p.1). According to the results of the science exam for the study state, the assessment item for this content standard has a low student *p*–value, $p = .45$. Students struggle with the assessment item for this standard.

Examining the content objectives from three different syllabi in the study district, the following objectives are noted: (a) "The student will explain how various factors such as temperature and pH affect enzyme function" (The Study District Biology Syllabus, 2008, p.20); (b) "the student will relate the study of rates of reactions to kinetics (The Study District Chemistry Syllabus, 2007, p.31); and (c) the student will "identify and explain the major factors influencing the rate of reaction including surface area, temperature, nature of reactants, and concentration" (The Study District Chemistry Syllabus, 2007, p.31). From the review of the objectives, it can be seen that students taking these classes have the opportunity to know how reaction rates are affected by different factors. Neither the state content standard nor the syllabi objectives from the study district suggest how students should engage with this knowledge, which may be part of the reason why the assessment results, indicated by the *p*–values, are low.

The comparable ROSE survey item queries students in two ways: By content interest and by context interest. Student interest is rated very low for the content survey item, "How interested are you in learning about chemicals, their properties and how they react," $M = 2.14$ (.95); however, the context item, "How interested are you in learning about explosive chemicals, has a higher mean score," M = 2.78 (.98). This result shows that when participants are surveyed about chemical reactions through the context of explosive chemicals, their interest, especially for boys, $M = 3.25$, is increased.

The draft NGSS complementary performance expectation states, "Students analyze and interpret data to support claims that the energy of molecular collisions and the concentration of the reacting particles affect the rate at which a reaction occurs" (NGSS Draft, 2012, p.69). When the proposed NGSS performance expectation is

examined, it can be seen that students are expected to be able to "analyze and interpret data to support claims" (NGSS Draft, Achieve, 2012, p.69). This aspect of the performance expectation addresses the practices of scientists stated in *A Framework For K12 Science Education* (NRC, 2010) and one of its guiding principles which is to give consideration to students' interests.

In this example, students are invited into legitimate peripheral participation through the practices of science and engineering, which are not evident in either the state standard or syllabi objectives for the study district. The second part of the performance expectation, "energy of molecular collisions and the concentration of the reacting particles affect the rate at which a reaction occurs" can be crafted to align with the context interest shown by the ROSE survey data. In this way, students can be invited to explore the work of chemists and engineers through reaction studies providing them with an apprenticeship view of purposeful design and manufacture of chemicals.

Example 2: Organisms and their physical environment. In this example, the state content standard states, "Students know relationships of organisms to their physical environment" (State Science Content Standards, 2004, p.3). The State assessment results show that students also struggle with this standard, $p = .52$ (State), $p = .51$ (District).

The biology syllabus objective from the study district states, "The student will interpret the relationships of organisms and their physical environment including food webs, commensalisms, and parasitism" (The Study District Biology Syllabus, 2008, p. 22). When queried through ROSE, participants responding to the complementary content item, "I want to learn about how people, animals, plants and the environment depend on each other," showed very little interest in the topic, $M = 2.10$ (.87). However, when

surveyed on the context item, “I want to learn about saving endangered animals,” students’ interest increases, $M = 2.64$ (1.05) especially for girls, $M = 2.75$.

The proposed NGSS performance expectation, “Student can construct arguments from evidence about the effects of natural biological or physical disturbances in terms of the time needed to reestablish a stable ecosystem and how the new system differs from the original system,” (NGSS Draft, 2012, p.38) engages students through legitimate peripheral participation by asking them to participate in a scientific practice by constructing an argument from evidence. Students must use evidence, which they either develop themselves or gather through research or instruction. Students must evaluate the evidence for scientific credibility as they craft their argument. These are the practices and processes used by scientists.

The quality of the NGSS performance expectation is more sophisticated than what is currently being asked of students by both the state and study district. Given that the processes and practices of scientists are sophisticated, this performance expectation represents a new level of student engagement and represents how the NGSS classroom includes students in the apprenticeship behaviors of scientists and supports the guiding principles of the *Framework* by giving consideration to students’ interests.

Example 3: Characteristics of stars. In this example, the State content standard asks students to” know common characteristics of stars” (Study State Science Content Standards, 2004, p.2). The State assessment results show that students struggle with this standard, $p = .51$ (State), $p = .50$ (District). There are no objectives in the Chemistry or Biology syllabi from the study district that relate to this standard; however, there is a

standard in the Geoscience syllabus, which states, “The student will describe characteristics of a star” (Study District Geoscience Syllabus, 2009, p.32).

In ROSE, items about the universe are of high interest to students. Even expressed strictly as “I want to learn about stars, planets and the universe,” participants rated the item reasonably high, $M = 2.80$ (.94); however, when framed in the context of, “I want to learn about supernovas and spectacular objects,” the ratings increased significantly, $M = 3.02$ (1.00), especially with boys, $M = 3.18$ (.90).

The proposed NGSS performance expectation, even as a draft standard, increases the cognitive demand on the students by asking them to “construct explanations for how the Big Bang theory accounts for all observable astronomical data” (NGSS Draft, Achieve, 2012, p.51). Students are invited into the world of the astronomers through legitimate peripheral participation. They must use the conceptual tools of the community of practice of science by constructing an explanation from evidence using the Big Bang theory and defending how the theory accounts for all of the observable astronomical data. This is not a fill–in–the–blank standard but expects a level of academic behavior from the students requiring that they use scientific practices, tools and reasoning of the community of practice of science.

Example 4: Engineering. The final example supporting how the NGSS will engage students in science through legitimate peripheral participation is entirely new for the current K–12 science education system. The NGSS performance expectation does not have a counterpart from the State or study district. The performance expectation states, “Students can obtain, evaluate, and communicate information to show how scientists and engineers take advantage of the effects of electrical and magnetic forces in materials to

design new devices and materials through a process of research and development" (NGSS Draft, 2012, p.84).

This is an ambitious standard that will require much research and work on the part of the students (and their teachers). The science and engineering practices are distinctly identified in the standard immediately engaging the students. The ROSE items complementary to this NGSS performance expectation include: (a) "I would like to learn about how mobile phones can send and receive messages, $M = 2.55$ (1.02); and (b) I would like to know how I–pods, CDs and DVDs store and play sound and music, $M = 2.86$ (.99). The mean scores evidence the higher interests among participants, especially boys, M = 2.90 (.95). Developing the curriculum for this performance expectation will require sophisticated understandings of the science and engineering, and is an excellent opportunity to engage students in legitimate peripheral participation by giving them the opportunity to incrementally increase their skills through well-conceived and authentic activities which they may find connected to their everyday lives.

Summary Results: Research Question 2

An examination of the examples used for Research Question 2 demonstrates that currently, the State Science Standards and the syllabi content objectives from the study district may not succeed in engaging students in legitimate peripheral participation because, as they are written, the standards and objectives separate the natural integration of content and scientific and engineering practices, which isolates both dimensions making it difficult for teachers and students to access. This artificial separation seems to lead to a lack of deep understanding on the part of students as evidenced by the State science exam *p*–values on the assessment items in the preceding examples. The proposed

NGSS draft standards, even in their roughest forms, demonstrate how students can engage in legitimate peripheral participation by crafting well-envisioned standards that encompass one or more of the practices of scientists which are the conceptual and physical tools of the community of practice, and the engagement of students in authentic activities which increase in sophistication through their K—12 science experience.

Research Question 3: Student identities as future scientists

Research question 3 asked, "Based on their school science interests and perspectives, what can be inferred about students' identities as future scientists or STEM field professionals?" This question uses data from both "My school experience" and "My future job" on ROSE. Examination of "My future job" reveals that girls are very passionate about a future job that fits with both their attitudes and values, and which is meaningful. Boys are more interested in jobs where they can make their own decisions and still use their talents and abilities. Table 24 presents the mean scores of girls and boys on job related conditions, which they scored as very important to them.

Table 24

My Future Job: Means Boys and Girls by High Interest Item

High Interest Items	Girls	Boys
	Means (SD)	Means (SD)
Working with something that fits my attitudes and values	3.37 (.82)	3.34 (.81)
Working with something I find important and meaningful	3.51 (.73)	3.35 (.80)
Making my own decisions	3.43 (.74)	3.43 (.74)
Using my talents and abilities	3.36 (.88)	3.39 (.84)
Developing or improving my knowledge and abilities	3.39 (.78)	3.27 (.84)
Helping other people	3.37 (.82)	2.29 (.90)
Earning lots of money	3.10 (.92)	3.34 (.89)
Having lots of time for my family	3.24 (.83)	3.15 (.88)
Working as part of a team with many people around me	3.00 (.85)	3.05 (.88)

Job conditions that are of least importance to girls and boys are tabulated in Table 25. The two least important job conditions for both girls and boys are controlling people and becoming famous. It is of interest to note that participants of both genders are not interested in working in areas that are easy and simple, or in the area of environmental protection and animals. Many participants cited high interests in studying animals, yet are not interested in working with animals. However, it is compelling to note that the practices of scientists listed in *A Framework for K–12 Science Education* aligns with the expressed interests of students. For example, the practice of communicating and

collaborating intersects with students' desires to "work as part of a team with many people around me." The items about "making my own decisions" and "using my talents and abilities" fit nicely with the practices of "asking and developing questions" and "designing solutions." School science could be designed to take better advantage of students' intentions around work they would like to do and the classroom experience by utilizing the practices of scientists.

Table 25

My Future Job: Means Boys and Girls by Low Interest Item

Low Interest Items	Girls	Boys
	Means (SD)	Means (SD)
Building or repairing objects using my hands	2.12 (.97)	2.69 (1.02)
Working with something easy and simple	2.33 (.93)	2.38 (.100)
Working in the area of environmental protection	2.38 (1.03)	2.33 (1.05)
Working with animals	2.41 (1.15)	2.20 (1.01)
Becoming famous	1.89 (1.03)	2.23 (1.18)
Controlling other people	1.86 (.91)	2.11 (1.01)

Summary Results: Research Question 3

It would appear from the ROSE data in this study that school science experiences have done little to influence students to choose science careers. Table 26 summarizes participants' responses on selected ROSE career interest items. Participants of both genders are not inclined to become scientists, although boys show a higher interest than girls in getting a job in technology. School science classes for the study group of participants have not "opened their eyes to new and exciting jobs."

This finding is an area for future study given that two of the participating schools have career and technical education programs. Perhaps, students in these programs did not make the connection to their science classes. Equally plausible is that their science classes did not model career opportunities. Although a modest finding, participants did think that the science they learned in school would improve their career chances; and finally, the item that surveyed participants about the importance of science, clearly showed that participants did value science. They just do not want to become scientists.

Table 26

ROSE Career items

Rose Career Items	Girls		Boys	
	N	Means (SD)	N	Means (SD)
School science has opened my eyes to new and exciting jobs	269	2.24 (1.15)	199	2.40 (1.12)
I think that the science I learn at school will improve my career chances	272	2.60 (1.15)	196	2.71 (1.14)
School science has shown me the importance of science for our way of living	272	2.62 (1.09)	194	2.80 (1.11)
I would like to get a job in technology	272	1.80 (1.02)	197	2.81 (1.12)
I would like to become a scientist	273	1.66 (.99)	195	1.79 (1.04)

Summary

The three research questions asked in this study were examined through the use of the ROSE survey. Findings for Research Question 1 indicate that boys and girls continue to show marked differences in scientific topics of interest. The five highest mean scores

in science context and content topic themes for all participants include: Mystery, Fitness, Issues related to Youth, the Universe and Animals. The five lowest mean scores in science context and content topic themes for all participants include: Plants, STS, Energy, Chemistry and Technology. There were no statistical differences among ethnic groups although some groups had slightly lower mean values. Context influences student interests. Content items linked to a context increased participants' mean interest scores.

Research Question 2 found that participants increased their interest when the context of the content is connected to their everyday lives. Comparison of State Science Content Standards and curriculum objectives from the study district revealed a focus on content and not context. *The Next Generation Science Standards* (Achieve, 2012) are being constructed to pique students' interests through the intentional and integrated use of the scientific and engineering practices, which will situate content in relevant context. The level of sophistication anticipated for high school students in science will increase across the grade levels providing them with more authentic science experiences appropriate and engaging for adolescent students.

Findings for Research Question 3 show that participants in this study do not see themselves as scientists or as becoming scientists. While students value the importance of science in their lives and think all students should take science, they do not aspire to careers in science. Current school science does not seem to support students' career interests. Yet, a composite emerges, which reveals that students aspire to careers that are fulfilling and which use their talents and abilities allowing them to make their own decisions. Legitimate peripheral participation in a thoughtfully constructed Next Generation Science classroom could capitalize on these aspirations.

Future work has been identified with African American students whose representation in this study was small in comparison to the other ethnic groups. Urban students were not well represented in this study and their perspectives could help teachers understand equity issues. Further work is needed to understand the interests of Hispanic students whose mean content and context scores seemed slightly lower, although not statistically significant, from the other participants in this study. Most participants expressed little interest in knowing about topics of environmental protection, STS, energy and plants. These are important topics in contemporary science and why participants expressed such low interest is an area of future work. Finally, future work addressing students' career interests is important given that participants attending the study district specialized science academies expressed low interest in science and technology careers.

The study is limited by the survey nature of the research. Interviews with participants might have clarified low areas of interests and also enlightened understandings of high interest topics. More items on the survey could have led to better clarity around the topics, but the generous time provided by teachers in this study could not have been further stretched.

Chapter 5

Discussion

This study used the *Relevance of Science Education* (ROSE) to survey high school participants regarding their perceptions about science, their school science education, and their future science plans. Urban, rural and suburban schools in the study district were invited to participate in this study and attention was given to ensuring representation of both comprehensive high schools and career and technical education schools. While there was participation from a variety of these schools, only one urban science high school class elected to participate in the voluntary study. This chapter, framed by a situated learning perspective, will provide an overview of the study's findings followed by a discussion of the results as they relate to each of the research questions.

General Impressions from the Findings

The study results indicated that a statistically significant gender gap or difference in interests exists between girls and boys in many science content topics; however, no statistically significant differences were observed among girls of different ethnicities or among boys of different ethnicities. Overall, participants' interest ratings increased when science content topics were placed in a context, although gender differences persisted, for example, boys preferred topics about technology more than girls did. No statistically significant differences among girls of different ethnicities or boys of different ethnicities were observed when science content was placed within a context.

The highest mean scores observed in the science content and context topic categories for boys included mystery, issues related to youth, the universe and

technology. African American boys had high interests in topics about human biology. For girls the highest mean scores were observed for the categories of mystery, issues related to youth, human biology, and fitness. Asian girls held high interest for technology topics and White girls had high interests in topics about animals. The lowest mean scores noted in science context and content topic themes for boys included plants, relevance and everyday use, beauty and aesthetical aspects subjects. For girls, the lowest interest areas included science, technology and science; plants; energy; and relevance and everyday use themes. After the data were separated by gender, there were no statistically significant differences noted between ethnic groups although some ethnic groups recorded slightly lower mean scores than other groups. The overall findings were that topic contexts influence participants' interests, and girls and boys have different science topic interests. In this study, content items linked to a context increased participants' mean interest scores.

When queried about their school science experiences, participants of both genders and all ethnicities found school science to be interesting but not as much as other subjects. Participants reported that school science was difficult, and yet they also responded that school science was interesting and easy for them to learn. There was a statistically significant difference between girls and boys in the category of "School science will influence my career choice" with boys giving higher ratings than girls; however, there was no statistical difference between the responses of boys and girls in the category of "School science is practical" with all participants having reasonably positive perceptions. Participants responded favorably to the survey items: (a) The things I learn in science at school will be helpful in my everyday life; (b) school science has shown me

the importance of science for our way of living; and (c) school science has improved my appreciation of nature. Of all the surveyed ethnic groups, African American girls and boys had the highest mean score for the latter item but not a statistically significant difference with other ethnic groups. Participants gave their lowest ratings to the query, "I want to be a scientist."

The current research project did not make any hypotheses about students' science topic interests or their respective views on school science and science in general. The next section endeavors to make sense of key findings in relation to the research questions, uncover potential implications for the science education community and offer some suggestions for changes that could be made by district leadership, teachers and students.

Exploring Research Question 1 Results

Research Question 1 asked, "What perceptions do students have about themselves and their science classroom and how might these beliefs be influencing their participation in the community of practice of science?" Items in the category of "What I want to learn about" asked participants to rate their levels of interest. In the study district, the elementary science curriculum focuses on cooperative learning and inquiry science. In middle school, the science curriculum also emphasizes inquiry instruction. These combined experiences should have afforded students the opportunity to engage in the practices of science through legitimate peripheral participation. If students have been youthful scientific apprentices throughout their school science experiences, it might be logical to assume that they would have expressed high science topic interests.

Context matters. Participants' responses to ROSE survey items in the category of "What I want to learn about" showed that when science topics were presented as

content items without a context, participants responded with low interest ratings. For example, “understandings chemicals and their behaviors” receive a very low rating by participants; however, when contextualized in the statement, “I want to learn about how explosive chemicals work,” ratings almost doubled. In his research, Sadler (2009) asserted that students engaged in school science experiences that were conducted in impoverished contexts and that school science activities were connected to artificial scenarios that were of little significance or importance to students. Students needed to participate in activities that used the tools and ideas of the community of practice. If Sadler’s assertion is valid, it may indicate that students’ interests are lessened and impeded by a lack of real experiences in the community of science from their earliest schooling. Over time, their interests are structured by their images of science conveyed in the classroom resulting in diminished interests. It may be that the typical science classroom in the study district needs a reframing of its classroom community of practice to be more inclusive of activities that students find important, practical and connected to their lives.

Stimulating students’ topic interests by creating legitimate peripheral participation in the community of practice of science through authentic science activities, hinges on providing contexts that support and sustain students’ curiosities (Lave & Wenger, 1991; Schreiner & Sjoberg, 2004). If a goal of science education is to graduate scientifically literate students and students who may wish to continue their studies in science, this is important (Roth & Lee, 2002). Relying strictly on the pedagogical practices of teachers to know that these connections must be made assumes that teachers have had experiences with the practices of science and engineering and have also had the opportunity to engage

in legitimate peripheral participation themselves (Johri & Olds, 2011). Knowing that context is important for all students, the school science community must continuously remind itself that practiced science does not occur without a context (Roth & Lee, 2003). Even though State science standards and the science syllabi objectives in the study district do not provide contextualized guidance needed for the development of science lessons that stress the science and engineering practices advocated by *A Framework for K–12 Science Education* (NRC, 2011), it becomes a responsibility for science educators to determine a suitable context for student legitimate peripheral participation in the community of practice of science.

Sadler (2009) addressed the importance of providing context for students when he argued that school science has developed a very narrow focus that cannot emulate professional science and that perhaps it was not necessarily a goal to have students doing professional science at school. He proposed a re-envisioning of the community of practice of science that would invite legitimate peripheral participation by engaging students in science as future participatory citizens. As observed in this study, without authentic context students disengage from science content. Sadler's proposal would situate learning in socio–scientific ideas and processes that are important to students. He suggested that classrooms develop communities of practice that "prioritize socio–scientific discourses and development of identities reflective of engaged citizenship" (Sadler, 2009, p. 12). This suggestion might provide an equity opportunity for non–mainstream students often disenfranchised by school science (Basu & Barton, 2005; Lee & Buxton, 2010; Seiler, 2009) and which this study could not address because the participation by urban schools was so limited.

Gender matters. This is not the first study to suggest that girls and boys have differing science topic interests but it bears concern that after so many years of discussion and work by researchers that gender differences continue to be so persistent (Sjoberg & Schreiner, 2004). It may be that in a very complex way, girls and boys receive different invitations to the community of practice of science that are uniquely conveyed through curriculum and instruction and are not readily revealed through a survey. This remains an area for continued research (Aschbacher, Li & Roth, 2009). This study did find topics that are mutually interesting to both genders and can become areas of congruence in which to optimize students' interests.

Participants of both genders, but most especially boys, and all students of all ethnicities expressed high interests in topics about the universe. This is a fascinating finding given that the biology and chemistry curriculum syllabi from the study district have no references to the universe in any of its objectives. The State has standards about the universe but these standards provide little guidance to help make connections for teachers as they design their lessons. This finding shows how participants' identified science interests can positively influence science syllabi development and resultant curricula to coordinate and contextualize science content topics and which address gender differences. It would be an area of future work to craft curricula sensitive to the mutual interests of science students and work with teachers to implement the curricula in their classes. It could provide an opportunity to experiment with authentic activities to foster the legitimate peripheral participation of students into the community of practice of science.

Girls of all ethnicities expressed higher interest than boys in topics related to human biology, although boys expressed higher interests when the topics were about fit bodies. Redesigning the biology curriculum or even some biology lessons to include more focus on the content related to human anatomy and physiology, could enhance students' interest and open avenues of thought about related science careers. *A Framework for K–12 Science Education* (NRC, 2011) approached several key life science topics through the lens of neuro–biology. This approach would enable students to explore key life science topics situated in the context of the brain and the nervous system. Partnerships with local hospitals or nursing schools could bring curricular programs such as *Understanding Neurobiology through the Study of Addiction* or *Looking Good Feeling Good* developed by the National Institute of Health into the biology curriculum thus capitalizing on boys interests in fitness topics and girls' interests in health topics.

Boys of all ethnicities expressed moderately high interests in physical science topics, such as sound, light and energy, especially when the topics were contextualized in some form of hullabaloo as exemplified by high interest response to the item "I am interested in learning about explosive chemicals." This finding demonstrates that participants, especially boys, have an interest in chemistry. They are not interested in the abstract and isolated facts of chemistry but rather in the way in which chemistry explains how dynamite works, or everyday observations such as why a warm can of soda seems to explode when opened, or why baking soda and vinegar have such a rigorous reaction. Given that industries are expressing concerns regarding a lack of future workers in resource areas such as energy, electricity, and technology (National Research Council, 2011), the opportunity to improve curriculum and instruction with the end result of

increasing student exposure to authentic science experiences in these areas seems logical especially for girls who expressed very low interest in physical science topics but also an enticement to boys who have indicated their interests. It is clear though that even if students may have an expressed interest in a particular contextualized topic, how the teacher allows the students access to that topic influences whether the student is actually invited to engage in legitimate peripheral participation. For example, a teacher, knowing that her students are interested in radioactivity, might arrange for scientists in the field to speak to her class, or for her students to visit a facility that manufactures isotopes say for medical tests. Such activities might serve several purposes including extending students' interest in the science of isotopes, providing practical yet important examples of how isotopes are used in everyday medical tests, and giving students the opportunity to meet and hear speakers discuss why they choose to pursue a career in this field.

Participant differences. This study shows a continuous and statistically significant gap between girls and boys in their science topics of interests, although the findings did not show statistically significant differences among ethnic groups. Participants of all ethnicities consistently had similar interests and disinterests although their calculated mean scores may have varied. This is a positive finding because it suggests that a well–designed curriculum sensitive to topics that all students find of interest in science could be developed with appeal to all students. However, the finding needs further examination, as the participants in this study did not fully represent the urban student population. Furthermore, respondents voluntarily took the ROSE survey. The voluntary nature of this study could be interpreted to mean that these participants were already motivated students. Differences between student groups reported by other

researchers (Lee & Buxton, 2010) may not have been observed in this study due to the survey's voluntary nature.

Low interest topics. Science topics of low interest to participants need examination. Girls responded with their lowest rankings for science content topics about plants and botany, physical science topics specifically including chemistry, light, energy and electricity while boys expressed lowest interest in content topics about plants and botany, geo–science, and non–contextualized topics about light. When topics were contextualized, girls and boys gave their lowest ranking to topics about science, technology and society; beauty and aesthetics of science; everyday use; and environmental issues. Given that these students will, as citizens, be coping with local, regional and global problems, they will need to be able to understand the complexities concerning adequate resources including clean air and water, energy sources, and the agricultural crops which all citizens consume for food (Roth & Lee, 2003; Sadler, 2009; Schreiner, 2006).

The State science standards and syllabi documents from the study district do not address these subjects in the contexts described which may be why students express such low interests in studying these particular science topics. It is also possible that given their lifestyles, participants do not see plants becoming food or their drinking water as a product of the water cycle and complex industrial purification systems. Their faucets easily dispense clean water, their light switches provide energy, and their grocery stores sell food. Students may not make connections between the activities they take for granted and the supporting scientific and engineering concepts that allowed the technology to be created and developed (Schreiner, 2006). Understanding these complex

issues takes time and a re–envisioning of the science curriculum for its connectedness to students' everyday lives, which teachers may not be willing to do given the high stakes testing environment in the study state. Certainly, opportunities exist to engage the industries in the community to provide students with experiences around the energy and water needs of the community, but unless the teacher or school district personnel actively seek this engagement, students will have no real experiences to contextualize these scientific topics in their lives.

School science experiences. How students experience school science influences their interest levels. The ROSE survey included items that were classified into three categories: (a) school science is interesting; (b) school science will influence my career choice; and (c) school science is practical. These three categories help clarify understandings about whether respondents view themselves as active participants in the community of practice of science. Findings showed that boys found school science to be more interesting than girls; were more likely to agree that school science influences their career choices; and that school science was practical. Even though boys responded more positively than girls, their rankings were still low. It is of concern that barely 50% of girls and less than 60% of boys thought their school science experiences might influence their career choice.

Science and technology offer many meaningful careers that support values that the students indicated were important qualities in selecting a career. Certainly, the science curriculum and its supporting activities should foster such interests, but this study suggests that either the students do not care or they do not have the school science exposure or experience to respond positively. The low participant responses in any of

these three categories suggests that there are opportunities to improve the science classroom experiences by developing curriculum activities which are authentic or which simulate science experiences that situate for students the work that scientists do. This finding lends support for the premise that the current science classrooms in the study district do not explicitly embrace the idea of students as apprentice scientists and hence, they are not afforded legitimate peripheral participation. It further supports the proposal to re–envision the science classroom community situated around socio–scientific issues important to students (Lee & Roth, 2003; Sadler, 2009).

Exploring Research Question 2 Results

Research Question 2 asked, "Considering a future science classroom where the curriculum is framed by the *Next Generation Science Standards* (NGSS) how might the standards support students' beliefs and perceptions about science education and their legitimate peripheral participation in the community of practice of science?" Participants' survey responses on selected ROSE items were used to frame an argument that the current State science content standards, the resultant curriculum syllabi documents from the study district and the high school science achievement test item *p*–values do not provide contexts for students to situate the corresponding science content in their experiences.

Three different content standards were contrasted with ROSE items that received low student interest ratings. The three focus standards included: (a) chemical reaction rates; (b) the relationship between organisms and their environment; and (c) common characteristics of stars. When the *p*–values from the state science assessment were added to the comparison, it was evident that student achievement as well as interest on these

items was low. Perhaps without a situated context, students did not understand or connect with the science content, as evidenced by their low scores on the corresponding state science exam content topics and their low interest rating on ROSE. For each focus standard, a complementary NGSS performance expectation was selected to evaluate whether the proposed standards could situate student learning in science and engineering contexts that are significant for students and which meet the *Framework* principle of giving consideration to students' interests. While this is not a proof that student achievement will increase with the NGSS, it could be suggested that teachers and curriculum designers will have an opportunity to consider how to better engage students in authentic science that invites legitimate peripheral participation in the community of practice of science.

It is also evident that future science classrooms implementing NGSS will be extensively reliant on the implementation of the practices of science and engineering (NRC, 2011), and these practices have use the conceptual tools of the community of practice of science which will pose an instructional shift and potential problems for teachers perhaps who may not be confident in their science content knowledge. A shift to using the conceptual tools of the community of practice with students may pose problems for teachers but also for English language learners and for students who have not experienced legitimate peripheral participation in the community of practice of science. The study district will need to re–write its curriculum documents to reflect the changes and will need to create professional development experiences for teachers to develop their skills in using the practices of science as described in the *Framework*. Teaching methodologies anchored by lecture will not provide students with equitable access to the

NGSS performance expectations, which will require fluidity with the practices: asking questions and defining problems; developing and using models; planning and carrying out investigations; analyzing and interpreting data; using mathematics and computational thinking; constructing explanations and designing solutions; engaging in argument from evidence; and obtaining, evaluating and communicating information (NRC, 2011).

The NGSS will be unique standards for American schools, but across the globe many organizations are trying to improve science education. The United Nations Educational, Scientific and Cultural Organization (UNESCO) released a report, *The Perth Declaration* (2008) describing emergent issues facing science education policy–makers. The education concerns addressed in the report help to expand the discussion on how to develop a classroom based on the NGSS. *The Perth Declaration* (2008) points out that all countries are faced with balancing the need to develop future scientists with the need for "giving all students an interest in, and enough knowledge of science and technology to appreciate the importance of science and technology in society" (UNESCO, 2008, p. 15). The report suggests that students' younger years in science be spent on "stimulating curiosity and appreciation of the beauty, wonder and curiosity about the natural world" (UNESCO, 2008, p.16) while later years focus on courses that will equip students to "participate in the big socio–scientific issues of today" (UNESCO, 2008, p.16). This is very interesting given that in this study, participants gave very low ratings to topics about aesthetics and beauty (as did their peers from around the world). A re–conceptualization of an NGSS classroom would center on the articulation of the pre–kindergarten through fifth grade school science experiences.

Science teachers can capitalize on their students' funds of knowledge and repertoire of practices (Seiler, 2011) by recognizing and acknowledging that science is one way to understand the natural world but that students may come from cultures that have had long histories of observing and understanding the world. Aikenhead (2004) suggested a humanistic approach to science instruction emphasizing "science as one of the great human enterprises in the history of civilization. Each concept and principle in science textbooks is recognized to be the result of great human drama" (UNESCO, 2008, p.21). This helps situate science in real world experiences of students and supports the NGSS by bridging home cultures with the science classroom cultures through pertinent and applied curricula. This bridging of cultures would work towards more equitable legitimate peripheral participation by non–mainstream students. This study could not discern ethnic differences among its student participants, but that does not mean that they do not exist. Osborne (2010) has suggested that surveys such ROSE are important sources of information about student perspectives but that the items need finer tuning to elicit deeper understandings from the students.

It is expected that when the NGSS are completed, its performance expectations will provide the necessary direction to assist teachers in developing the authentic experiences that invite students into legitimate peripheral participation but significant professional development for both teachers and administrators will be needed. Further, the emphasis on the practices of science provides a unique opportunity and strategy for engagement of non–mainstream students (Lee & Buxton, 2010; Quinn & Lee, 2012). Legitimate peripheral participation can be achieved if the classroom teacher understands how the NGSS, through the incorporation of the science and engineering practices, uses

dialog, and how this science dialog becomes the vehicle in which to engage students from different backgrounds, languages and cultures.

Exploring Research Question 3 Results

Research Question 3 asked, "Based on their school science experience, what can be inferred about students' identities as future scientists?" The specific ROSE survey items used to explore this question were in the categories, "My school experience" and "My future job." In their responses, participants responded with high ratings for items such as "I want to work with something that fits my attitudes and values; with something I find meaningful; and make my own decisions." Girls, more than boys, responded positively to the statement, "I would like to work in a job helping other people." Participants of both genders and all ethnicities expressed little interest in careers that would make them famous or in which they could control other people, although boys did rank the items higher than girls. Paradoxically, two of the participating schools have career and technical education programs leading to opportunities in the science and technology fields, yet the survey results indicate a disconnect between personal aspirations and school experiences.

Students begin to develop their career choice ideas as young as upper elementary school but certainly by middle school (Girl Scout Research Institute, 2012). Research has suggested that these career choices were based on multiple factors but in science, there were a few factors, which importantly impacted student perceptions. These included influence of stereotypes, family, friends and teacher support but also student success in prior science classes (Hazari et al., 2009; Williams et al., 2003). Boys often cited their scientific knowledge as developed through hobbies, scouting or other out–of–school

experiences that girls may not have had (Hazari et al., 2009). In a study on physics identity, two characteristic predictors that were the responsibility of students in the development of positive physics identity were found: (a) making comments and answering questions, and (b) teaching another classmate (Hazari et al., 2009). Both of these activities help build a student's self–perception and confidence as capable of doing science; however, these activities must be part of the classroom community of practice.

> It is not enough for teachers to prepare students for performing required tasks or making the subject interesting. Teachers need to also provide opportunities for recognition, recognize students themselves, and focus on practices, such as conceptual understanding, that will not only increase competency but also feelings of competency. (Hazari et al., 2009, p.998)

Identity building is a function of time, a positive classroom experience and the building of expertise (Johri & Olds, 2011; Sadler, 2009). One interpretation of this study's results seems to suggest identity building has not been part of the participants' school science experiences. Not only have students not had enough time on science through their years of schooling, but the time spent thinking they were youthful scientists also seems diminished. Participants in this study expressed strong desires to be successful and to have a meaningful career but not in science. This may be in part due to the unforeseen consequences of NCLB policies, which direct more time towards English language arts and mathematics and less time for science leaving students unfamiliar and uncomfortable with the discipline; however, given the diversity of the student population in this study, other factors noted by Lee and Buxton (2010) may also be having an

impact. Such factors explore the culture that students bring from home, their language, their ideas about schooling, and their previous success in school science.

Research has shown that due to a lack of training and at times, negative biases, many teachers do not capitalize on students' outside school knowledge and experiences and as such, marginalize this potential reservoir of student intellectual resources (Lee & Buxton, 2010). As a result, many students have not had the same opportunities to participate in rigorous, grade–level science. When the science classroom environment is intentionally designed to involve students "in talking, thinking and problem solving in the world, and when these practices are explicitly taught, non–mainstream students embrace the role of bicultural and bilingual border crossers between their own cultural and speech communities and the science learning community" (Lee & Buxton, 2010, p. 174). Although Lee & Buxton are speaking about English language learners, the larger point is that students will "explore and embrace academic and scientific identities" (Lee & Buxton, 2010, p. 174) when the classroom is a community of practice of science. The overall desire of students to find meaning in their lives as expressed in the survey data also includes meaning in their school lives. Educators can use this information as an opportunity to consider intentionality in the science classroom environment to provide the experiences that capitalize on student knowledge and practices while helping them see themselves as youthful scientists who have a contribution to make (Lee & Roth, 2009).

Further, students do not seem to understand that many scientists work in areas of research which help society such as in solving environmental problems, developing new medications, designing ways to safeguard foods, or keep water safe and clean by

extraction of harmful chemicals. Participants did not give high ranking to any of these items in the "What I want to learn about" category or in "My school science experience" categories. This seems to imply that participants do not make the connection between what they value as important attributes in a career with a corresponding career in science. Somehow, the attributes that define a career in science do not seem to correlate for students. It follows that students have not developed a strong and positive science identity since they cannot picture themselves as potential scientists. Students' responses to the item, "I want to be a scientist" were the lowest ranked item on the entire survey. There is a mismatch between the items, "Science is important for society," which received high ratings and implies that students value the attributes of science, and "I want to be a scientist," which received the lowest ratings of all items.

Students taking the *Programme for International Science Assessment* (PISA) (2006) assessment were surveyed about their career choices and interests. Results from twenty-four countries showed that girls were more ambitious than boys, but they were more likely to identify with careers as legislators, managers, or senior–level officials. The PISA results showed that on average only 11% of students completing the survey expressed an interest in pursuing health related fields and of this number more girls than boys expressed interest. The same percentage was reported for students showing interest in computing or engineering as a career with more boys than girls expressing interest. The observation is that it is not for a lack of ability but rather the image of the field as being too difficult, too abstract and only for some types of students (Williams et al., 2003). It may be that across the study district much like across the world, participants have not been engaged in authentic science problem solving, which has been found to

build career interest (Basu & Barton, 2005). Science should and does exist beyond the classroom and beyond the confines of professional science into the world that students experience as participatory citizens. A proposed solution calls for re–engaging students by developing classroom communities of practice which capitalize on discourse and "identities reflective of engaged citizenship" (Sadler, 2009, p. 12). In this image of engaged citizenship, students and their teachers would together explore important issues or problems which characteristically require access to the procedural and conceptual connections to science and they must be of social importance (Sadler, 2009). In this science classroom community of engaged citizenship, identity development occurs naturally as students work on the ill–structured problems posed for their study thus gaining in expertise and confidence in the norms of the community of practice of science.

It may be that since the implementation of NCLB (2001), classrooms have been focused on testing and have not concentrated on conveying the importance of science for students resulting in a lack of understanding about their potential future opportunities. It may also be that teachers need professional learning for themselves about student identity development (Johri & Olds, 2011). Participants all exhibited optimism for and strong interest in their future careers. They indicated a desire for occupations that are fulfilling and meaningful and enable them to earn a living. This indicates the potential opportunity for the school system to reflect on the ways in which to foster and connect these interests and desires to the science experiences students have throughout their twelve years of school.

Closing Thoughts

The advent of standards–based instruction was intended to bring equality to science education for all students, but this movement seems to have inadvertently led to the distillation of the standards into content bullets called power standards, which in turn became a checklist of material to be covered during instruction. With the advent of high stakes testing, the practices of science and engineering as they were envisioned in the NSES Inquiry Standards (NRC, 1996) slowly dissipated until the school science, which students experienced, became unrecognizable as authentic science or the science practiced by the science community (Aikenhead, 2000; Sadler, 2009). It is impossible under such an instructional model to invite students into the community of practice of science. Their legitimate peripheral participation in the community of practice of science, which should have begun in the elementary grades, stalled or never was actuated.

This study found that participants' interests in science topics exist for all students but topics must be contextualized, made practical and connected to students' everyday lives and home cultures. In this study, with this group of student participants, differences in science interests among ethnic groups were minimal while significant differences remain between girls and boys. Knowing the topics that are of greatest interests to both girls and boys and which can be used to engage non–mainstream students, informs the design work of curriculum writers especially with the anticipation of the *Next Generation Science Standards*. Better systematic cognitive apprenticeships should be initiated at younger ages to build on the interests that boys have but also to invite girls to identify with these particular fields (Dewitt et al., 2010). Consulting students about their interests

and whether the content is important and practical may enhance their motivation to pursue more science (George, 2007; Jenkins, 2006).

Conclusion

This study explored the interests of the study district's student participants through the following research questions:

1. What perceptions do students have about themselves and their science classroom and how might these beliefs be influencing their participation in the community of practice of science?
2. Considering a future science classroom where the curriculum is framed by the *Next Generation Science Standards* how might the standards foster students' beliefs and perceptions about science education and their legitimate peripheral participation in the community of practice of science?
3. Based on their school science interests and perspectives, what can be inferred about students' identities as future scientists or STEM field professionals?

Some facets of these research questions have been explored in previous decades by researchers, yet issues such as student science interests and gender have persisted (DeBoer, 2000; Hurd, 2001) even though there have been efforts to improve curriculum and pedagogical practice (Sjoberg & Schreiner, 2004). This indicates that the science education community must continue to research and develop better understandings and strategies to find the appropriate intersections of students' interests and school science practice. The finding that the context of the science content strongly influences students' perceptions of the science topics is perhaps not novel, but it provides evidence to support rewriting curriculum objectives to help teachers contextualize content. The interest

ratings expressed by participants were quite low and should provide evidence for teachers and policy makers for decision making and curricula design that many students are not identifying with school science as they are currently experiencing it.

Socio–economic status was thought to be a factor in participants' interests; however, there was not enough student representation from high poverty schools to support the claim. Ethnic differences among participants were thought to influence their science topics of interests but the data did not support the assumption. Yet, a study by the Girl Scout Research Institute (2012) found that Hispanic and African American girls are confident in their abilities but are less likely than their White peers to know someone in a STEM field or to go to their parents for advice on career choices. It may be in this finding that future work needs to be pursued.

Perhaps the declining student interest in science is more a function of the classroom community of practice then it is socio–economic and ethnicity factors, and what happens or does not happen in the classroom bears heavily on students' perspectives. Participants are not connecting with their science classes. This study does not support any claim that the participants' perspectives are emergent at the secondary level, but rather postulates that the experiences children have had in science from their earliest schooling have shaped their notions about science and school science. As noted by UNESCO (2008), children have natural curiosities that should be encouraged and cultivated during the elementary years, yet it is well known that science during the formative elementary period has been severely curtailed due to *No Child Left Behind* (2001) policies (Lee & Buxton, 2010). This policy has very much impacted middle school science and high school science in the United States.

Student participants have areas of congruence in their interests as was found in the student profiles in topics of mystery, the universe and fitness/human biology. This leads to an obvious suggestion that teaching and learning might focus on these areas of mutual student interest and use science curriculum that is standards–based and which optimizes all students' interests. The leadership of the study district might consider professional learning opportunities for teachers and administrators about student identity development, the classroom community of practice and explicitly provide opportunities for teachers to experience legitimate peripheral participation in the science community of practice. It might be a worthy enterprise for the school district to convene, support and train a cadre of teacher leaders who can develop an articulated science alignment from kindergarten through twelfth grade that focuses on the science classroom community of practice of science and invites students to legitimate peripheral participation in authentic, practical and important science topics.

Limitations

This study was limited in several regards. Obtaining permission to conduct the study took almost half of the entire spring semester and narrowed the time in which the survey could be administered. Requirements of the study district and sponsoring university were often confusing and the lack of uniformity in the language on the forms resulted in submission of the same forms multiple times. Although many teachers from urban schools wanted to participate in the study, their principals would not give them permission to be involved. The opportunity to better improve the engagement of non–mainstream students needs further study.

The study would have been enhanced if student interviews could have been conducted. The survey format gathered over five hundred responses but selected interviews would have clarified some of the data responses. In the future, research should continue to focus on the demographic groups of students who richly form the study district and who struggle in science as evidenced by their assessment scores. The opportunity to better improve the engagement of non–mainstream students needs further study. Finally, it would be an area of research interest to explore classroom communities of practice to establish key characteristics that assist teachers to understand how to situate learning for non–mainstream students.

APPENDIX A

Letter of Acknowledgement

Letter of Acknowledgement of a Research Project at a District Facility

Office of Research Integrity – Human Subjects
University of Nevada, Las Vegas
4505 S. Maryland Parkway, Box 451047
Las Vegas, NV 89154–104

Subject: **Letter of Acknowledgement of a Research Project at a District Facility**

Dear ORI – Human Subjects:

This letter will acknowledge that I have reviewed a request by Ellen Ebert to conduct a research project entitled: Understanding Adolescent student perceptions of science education at _____ High School in _____.

When the research project has received approval from the Institutional Review Boards of UNLV and the Department of Research of the Study District, and upon presentation of the approval letter to me by the approved researcher, as site administrator for _____ High School, I agree to allow access for the approved research project.

If we have any concerns or need additional information, the project researcher will be contacted or we will contact the UNLV Office of Research Integrity – Human Subjects at 895–2794.

Sincerely,

_____ _____
Authorized Facility Representative Signature Date

_____

Print Representative Name and Title

APPENDIX B

Pre-notification Email

Date
Participant's Name
Participant's School

My name is Ellen Ebert, and I am a doctoral student at the University of Nevada Las Vegas. For my dissertation study, I am conducting research about student interest, experiences and their perception of their science education. Currently, very little is known about what students would like to learn about and how they perceive the importance of their science education studies.

My goal is to explore the various factors, which influence tenth grade science students' motivations and attitudes towards want they want to learn about as related to science.

You are invited to participate in this study because you have been identified as a science teacher with potential interest in this study. If you would like to participate, you should know in advance that there are several expectations. (1) You will be expected to obtain permission from your principal to participate in this study and have your principal sign the Study District Letter of Acknowledgement Form. (2) You will be expected to print the Student Assent and Parental Permission Forms for your students to take home and have signed. (3) You will be asked to collect these forms and send them to the volunteer at the central administration office. (4) You will need to schedule one class period in a computer lab for your students to take the survey. (5) You will need to involve at least one of your science classes and (6) you will be asked to participate and complete part of the survey. It is anticipated that this survey will occur in May 2012.

If you are able to fulfill these requirements, please send your interest to eberte@unlv.nevada.edu.

After all the paperwork is completed and collected, I will send you a link to a web–based survey. If you could schedule time in the computer laboratory for your science class to complete the survey as near to this date as possible, it would be **greatly appreciated.**

I am writing to you in advance so you will recognize the request when it comes and not inadvertently delete it. This study is important, as the results will be used to describe the interests of our student population of science students. The intent is to inform curriculum development, instruction and policy around science education.

Your generous participation in this study is most appreciated. Thank you in advance for your time and consideration.

APPENDIX C

Reminder Letter

Date
Participant's Name
Participant's School

In _____2012, you received an invitation to participate in a study for science students. The goal of this survey is to explore student interests and relevance of their science education. According to my records, your class is set to complete the survey during the month of May 2012. Attached are the permission forms that you and your students must complete in order to participate in the study. I anticipate the study results will be useful in helping teachers, schools and districts about the science interests of high school students.

When you have collected all of the Student Assent Forms and Parental Permission Forms, please return them to the central administration office through school district email. The volunteer will contact me and I will send you the online survey link for your class. It is anticipated that this survey will take approximately 40 minutes to complete.

I hope that you will be able to participate in this study, but if for any reason you prefer not to, or if this has reached you in error, please let me know by email.

Your assistance is greatly appreciated.

Sincerely,

Ellen Ebert, UNLV Doctoral Student
Department of Teaching and Learning
eberte@unlv.nevada.edu

APPENDIX D

Follow-up Letter

Date
Participant's Name
Participant's School

In _____, you were notified about a study for science students. The goal of this survey is to explore student interests and relevance of their science education. According to my records, your class has yet to reply to the survey. I anticipate the results will be useful in helping teachers, schools and districts about science interests of high school students.

I hope that you will have your students complete and send the questionnaire you can access via the secure link below, but if for any reason you prefer not to, or if this has reached you in error, please let me know by phone or email.

Click on this link or paste it into your Internet browser to access the survey:
_____

Sincerely,

Ellen Ebert, UNLV Doctoral Student
Department of Teaching and Learning
eberte@unlv.nevada.edu

APPENDIX E

Thank You Email

Date
Participant's Name
Participant's School

Hello!

Last week an online survey link was sent to you and your students to complete. This survey hopes to explore student interests and relevance of their science education.

My records show that your students have completed the online survey. I would like to thank you for your efforts in participating in this study with your students.

I am very appreciative for your help, because it is only by receiving information from science teachers like yourself that a better understanding of the unique challenges and needs of our science students can be gained.

Again, thank you for your time and assistance in this study.

Sincerely,

Ellen Ebert
UNLV Doctoral Student
Department of Teaching and Learning
eberte@unlv.nevada.edu

APPENDIX F

FINAL EMAIL

Date
Participant's Name
Participant's School

Greetings!

During the past month you have received several emails about a survey conducted as a part of my doctoral research at the University of Nevada Las Vegas. The purpose of this study is to explore tenth grade science students' interests and perspectives of their science education.

The study is drawing to a close and this is your final opportunity to participate. Your school volunteered to participate in this study and you were selected for your interest and because you teach tenth grade science.

If you prefer using a printed copy of the survey as an alternative to the Internet link, a MS Word version of the survey is attached for your convenience. Simply double click on the attachment, which will open using MS Word. Print it out, complete it, and return it to the address provided on the questionnaire. Of course, the Internet link option is still available to you as well.

If you would prefer not to participate in this study, or if you believe you have received this email in error, please respond and let me know. This would be helpful as we begin evaluating the data. Click on this link or paste it into your Internet browser to access the survey:

_____

Thank you again for your time and consideration.

We hope to hear from you soon!

Ellen Ebert
UNLV Doctoral Student
Department of Teaching and Learning
eberte@unlv.nevada.edu

APPENDIX G

Assent to Participate

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

ASSENT TO PARTICIPATE IN RESEARCH

Understanding Adolescent Student Perceptions of Science Education

1. My name is Ellen Ebert.

2. I am asking you to take part in a research study because I am trying to learn more about what high school science students in the district think about their science class experiences and their interests in science, science education, and science careers. Over 40,000 students from around the world have taken this survey and their voice is influencing how science education is changing in the 21st century. I would like to understand your ideas.

3. If you agree to be in this study, you will be asked to complete a survey that should take about 45 minutes.

4. There is very minimal risk to participating in this research survey. Some questions may make you think about your interest in topics that you have not thought about before and may feel confusing.

5. Some of the research questions may actually cause you to reflect more on your experiences in science and may remind you of your own interests. Your responses will contribute to our better understanding of what students your age would like to study.

6. Please talk this over with your parents before you decide whether or not to participate. We will also ask your parents to give their permission for you to take part in this study. But even if your parents say "yes" you can still decide not to do this.

7. If you don't want to be in this study, you don't have to participate. Remember, being in this study is up to you and no one will be upset or suffer negative consequences if you don't want to participate or even if you change your mind later during the survey and want to stop.

8. You can ask any questions that you have about the study. If you have a question later that you didn't think of now, you can send me an email. If I have not answered your questions or you do not feel comfortable talking to me about your question, you or your parent can call the University Office of Research Integrity – Human Subjects.

9. Signing your name at the bottom means that you agree to be in this study. You and your parents will be given a copy of this form after you have signed it.

_____ _____

Print your name Date

_____

Sign your name

APPENDIX H

PARENT PERMISSION FORM

PARENT PERMISSION FORM

Department of Education, Teaching and Learning

TITLE OF STUDY:

Understanding Adolescent Student Perceptions of Science Education

INVESTIGATOR (S): Randall Boone, PhD; Ellen Ebert

CONTACT INFORMATION: eberte@unlv.nevada.edu

Purpose of the Study
Your child is invited to participate in a research study. The purpose of this study is to survey the perspective of tenth grade science students in a metropolitan community concerning their science as important to their everyday lives, and how their views influence the decisions they make regarding courses they choice to study and careers they plan to follow. It will compare their understandings with their peers from around the world who have completed the same survey.

Participants
Your child is being asked to participate in the study because he/she is a high school science student.

Procedures
If you allow your child to volunteer to participate in this study, your child will be asked to do the following: Complete an online survey.

Benefits of Participation
There may not be direct benefits to your child as a participant in this study, although we hope to learn to learn more about student perceptions regarding their science education and their interests in taking more science or pursuing a career in science.

Risks of Participation
There are risks involved in all research studies. This study may include only minimal risks. Some questions on the survey may make your child think about his/her interest in science topics, which he/she has not previously considered.

Cost /Compensation
There will not be financial cost to you to participate in this study. The study will take 45 minutes of your child's time. Your child will not be compensated for his/her time.

Contact Information
If you or your child has any questions or concerns about the study, you may contact Ellen Ebert at eberte@unlv.nevada.edu. For questions regarding the rights of research subjects, any complaints or comments regarding the manner in which the study is being conducted you may contact **the UNLV Office of Research Integrity – Human Subjects at 702–895–2794, toll free at 877–895–2794, or via email at IRB@unlv.edu.**

Voluntary Participation
Your child's participation in this study is voluntary. Your child may refuse to participate in this study or in any part of this study. Your child may withdraw at any time without any negative consequences. You or your child is encouraged to ask questions about this study at the beginning or any time during the research study.

Confidentiality
All information gathered in this study will be kept completely confidential. No reference will be made in written or oral materials that could link your child to this study. All records will be stored in a locked facility at UNLV for 3 years after completion of the study. After the storage time the information gathered will be destroyed or deleted.

Participant Consent:
I have read the above information and agree to allow my child to participate in this study. I am at least 18 years of age. A copy of this form has been given to me.

_____	_____
Signature of Parent	Child's Name (Please print)
_____	_____
Parent Name (Please Print)	Date

APPENDIX I

Informed Consent Form

INFORMED CONSENT

Department of Education, Teaching and Learning

TITLE OF STUDY:

Understanding Adolescent Student Perceptions of Science Education

INVESTIGATOR (S): Randall Boone, PhD; Ellen Ebert

CONTACT INFORMATION: eberte@unlv.nevada.edu

Purpose of the Study
You are invited to participate in a research study. The purpose of this study is to survey the perspective of tenth grade science students in a metropolitan community concerning their science education as important to their everyday lives, and how their views influence the decisions they make regarding courses they choice to study and careers they plan to follow. It will compare their understandings with their peers from around the world who have completed the same survey.

Participants
You are being asked to participate in the study because you fit this criterion: Teacher.

Procedures
If you volunteer to participate in this study, you will be asked to do the following: Facilitate your students as they complete an online survey.

Benefits of Participation
There are no direct benefits to you as a participant in this study. However, we hope to learn to learn about student perceptions regarding their science education and their interests in taking more science or pursuing a career in science. Your assistance in conducting this survey is essential to its success.

Risks of Participation
There are risks involved in all research studies. This study may include only minimal risks. Some questions on the survey may be unfamiliar to you or your students.

Cost /Compensation
There is no financial cost to you to participate in this study. The study will take approximately 45 minutes of your time. You will not be compensated for your time.

Contact Information
If you have any questions or concerns about the study, you may contact Ellen Ebert at eberte@unlv.nevada.edu. For questions regarding the rights of research subjects, any complaints or comments regarding the manner in which the study is being conducted you may contact the UNLV Office of Research Integrity – Human Subjects at 702–895–2794 or toll free at 877–895–2794 or via email at IRB@unlv.edu.

Voluntary Participation
Your participation in this study is voluntary. You may refuse to participate in this study or in any part of this study. You may withdraw at any time without prejudice to your relations with the university. You are encouraged to ask questions about this study at the beginning or any time during the research study.

Confidentiality
All information gathered in this study will be kept completely confidential. No reference will be made in written or oral materials that could link you to this study. All records will be stored in a locked facility at UNLV for 3 years after completion of the study. After the storage time the information gathered will be destroyed or deleted.

Participant Consent:
I have read the above information and agree to participate in this study. I am at least 18 years of age. A copy of this form has been given to me.

_____ _____

Signature of Participant Date

_____

Participant Name (Please Print)

APPENDIX J

Volunteer Agreement

In accordance with the IRB agreement, the volunteer agreement form has been removed to protect the identity of the study school district.

APPENDIX K

IRB Approval Letter

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

Social/Behavioral IRB – Expedited Review
Approval Notice

NOTICE TO ALL RESEARCHERS:
Please be aware that a protocol violation (e.g., failure to submit a modification for any change) of an IRB approved protocol may result in mandatory remedial education, additional audits, re-consenting subjects, researcher probation, suspension of any research protocol at issue, suspension of additional existing research protocols, invalidation of all research conducted under the research protocol at issue, and further appropriate consequences as determined by the IRB and the Institutional Officer.

DATE: April 04, 2012

TO: **Dr. Randall Boone**, Teaching and Learning

FROM: Office of Research Integrity - Human Subjects

RE: Notification of IRB Action
Protocol Title: **Understanding Adolescent Student Perceptions and Relevancy of Science Education in a Southern Nevada School District**
Protocol #: 1202-4051M
Expiration Date: April 3, 2013

This memorandum is notification that the project referenced above has been reviewed and approved by the UNLV Social/Behavioral Institutional Review Board (IRB) as indicated in Federal regulatory statutes 45 CFR 46 and UNLV Human Research Policies and Procedures.

The protocol is approved for a period of one year and expires April 03, 2013. If the above-referenced project has not been completed by this date you must request renewal by submitting a Continuing Review Request form 30 days before the expiration date.

PLEASE NOTE:
Upon approval, the research team is responsible for conducting the research as stated in the protocol most recently reviewed and approved by the IRB, which shall include using the most recently submitted Informed Consent/Assent forms and recruitment materials. The official versions of these forms are indicated by footer which contains approval and expiration dates.

Should there be *any* change to the protocol, it will be necessary to submit a **Modification Form** through ORI - Human Subjects. No changes may be made to the existing protocol until modifications have been approved by the IRB. Modified versions of protocol materials must be used upon review and approval. Unanticipated problems, deviations to protocols, and adverse events must be reported to the ORI – HS within 10 days of occurrence.

If you have questions or require any assistance, please contact the Office of Research Integrity - Human Subjects at IRB@unlv.edu or call 895-2794.

Office of Research Integrity - Human Subjects
4505 Maryland Parkway • Box 451047 • Las Vegas, Nevada 89154-1047
(702) 895-2794 • FAX: (702) 895-0805

APPENDIX L

District Approval Letter

In accordance with the IRB agreement, the Study District Approval Letter has been removed to protect the identity of the participating study district.

APPENDIX M

The ROSE Survey

Relevance of Science Education (ROSE) Survey can be retrieved from

http://roseproject.no/?page_id=34

LIST OF TABLES

Table 1

Definitions Used in This Study

Term	Definition
Community of Practice	Groups of people who have a shared passion or concern for something they do together and through their regular interactions, they learn how to do it better (Lave & Wenger, 1991) eventually becoming experts. Members enact the conceptual and physical tools used by the community.
Cognitive apprenticeship	The engagement of students in tasks appropriate to the community of practice and which are slightly more difficult than they can individually manage requiring that they work collaboratively with their peers and perhaps their teacher in order to be successful.
Identity	Identity refers to how the student learns to speak, act and develop relationships and artifacts with respect to members of the community of practice.
Legitimate peripheral participation	The engagement of a learner (novice) through incremental authentic activities into a community of practice (experts) such that the learner gains competency and skill in the community's culture, norms and practices. In the community of science, novices learn the science and engineering practices which include asking and defining problems, developing models, communicating using scientific language, analyzing and interpreting data, engaging in argument, communicating information, using mathematical thinking, and constructing explanations.
STEM	Science, Technology, Engineering and Mathematics

Table 2

NAEP Achievement Scores for State 2009 and 2011 (NCES, 2012)

Group	Year	Below Basic	Basic	Proficient	Advanced
Nation	2011	36	64	31	2
	2009	38	62	29	1
State	2011	43	57	23	1
	2009	46	54	20	1
Boys	2011	45	55	21	1
	2009	39	61	28	1
Girls	2011	47	53	18	–
	2009	48	52	19	–
Hispanic	2011	57	43	12	–
	2009	61	39	10	–
Black	2011	69	31	7	–
	2009	66	34	9	–
White	2011	27	73	35	1
	2009	32	68	30	1
Asian	2011	32	68	31	1
	2009	37	63	26	1
English Language Learners	2011	86	1	2	–
	2009	95	5	–	–
Students of Poverty	2011	56	44	14	–
	2009	61	39	9	–
Students with Disabilities	2011	78	22	6	–
	2009	79	21	6	–

Table 3

Study District 2010 – 2011 Demographics (Study State Report Card, 2011)

Ethnicities	Study State	Study District
American Indian / Alaskan Native	1.2	0.6
Asian	6.0	7.1
Hispanic	38.8	42.1
Black / African American	9.9	12.4
White	38.7	31.8
Pacific Islander	1.1	1.2
Multi–Race	4.3	4.7

Table 4

2011 Science Assessment Data (Study State Report Card, 2011)

Students	State District	Number Enrolled	Achievement Standard			
			% Emergent/ Developing	% Approaches	% Meets	% Exceeds
Total	State	30 004	8.7	20.3	64.3	6.8
	District	21 229	9.7	21.4	62.9	6.0
Male	State	15 346	9.2	17.7	64.1	9.1
	District	10 927	10.4	18.6	62.9	8.1
Female	State	14 657	8.1	23.0	64.5	4.4
	District	10 302	9.0	24.3	63.0	3.8
Native American	State	354	9.5	23.0	64.7	2.9
	District	122	10.8	18.3	69.2	1.7
Asian	State	1 938	5.4	15.3	69.6	9.7
	District	1 599	5.9	15.5	68.9	9.7
Hispanic	State	10 464	13.0	28.6	55.6	2.9
	District	7 946	13.4	28.9	54.9	2.8
African American	State	3 162	17.8	31.2	49.3	1.7
	District	2 951	17.9	31.0	49.4	1.6
White	State	12 451	3.8	12.0	73.4	10.9
	District	7 318	4.0	11.9	73.9	10.2
Pacific Islander	State	343	8.2	17.8	67.5	6.4
	District	292	7.0	17.5	68.0	6.5
Multi–Race	State	1 290	4.0	13.8	73.7	8.0
	District	1 001	4.0	14.3	73.3	7.7

Table 5

Graduation Rates Study State vs Study District

(Study State Accountability Report, 2010)

Graduation Rates	Study State	Study District
% Total # of Students	70.3	68.1
% Male	68.1	66.3
% Female	72.3	70.0
American Indian / Alaskan Native	64.1	59.5
Asian	81.3	82.3
Hispanic	60.3	59.8
Black / African American	57.6	57.6
White	78.4	76.4
Pacific Islander	NA	NA
Multi–Race	NA	NA

Table 6

ROSE Content Themes (Schreiner & Sjoberg, 2004, p.54–5)

Content	Code	Number of Items
Astrophysics, Universe	U	12
Earth, Geo–science	G	10
Human Biology	H	23
Botany, Plants	P	7
Zoology, Animals	A	6
Chemicals	C	11
Light, colors, radiation	L	7
Sounds	S	5
Energy and electricity	E	6
Technology	T	5

Table 7

ROSE Context Themes (Sjboerg & Schreiner, 2004, p. 54 – 5)

Context	Code	Number of Items
Environmental Protection	W	8
Practical use, everyday relevance	R	9
Hullabaloo, spectacular phenomena, horror	Z	8
Health	Q	12
Fitness	F	7
Issues of particular relevance for youth	Y	7
Mystery, philosophy, wonder, quasi–science, belief–oriented	M	13
Beauty, aesthetical aspects	B	5
Science, Technology, and Society; Nature of Science	X	5

Table 8

Research Questions and Analysis Summary

Research Questions	Variable	Survey Items	Analysis
What perceptions do students have about themselves and their science classroom and how might these beliefs be influencing their participation in the community of practice?	Beliefs, Perceptions	Data source: questions from ROSE sections A, C, E ("What I want to learn about and me and my science class")	Descriptive statistics, *t* test analysis
Considering a future science classroom where the curriculum is framed by the Next Generation Science Standards how might the standards support students' beliefs and perceptions about science education and their legitimate peripheral participation in the community of practice of science education?	Classroom characteristics	Questions from ROSE sections A, C and E	Interest scores, *p* values, state content standards, district syllabi objectives, draft NGSS standards
Based on their school science interests and perspectives, what can be inferred about students' identities as future scientists?	Content interest; career interest	Questions from ROSE about future course selection and career interest.	Descriptive statistics, *t* test comparisons

Table 9

Proposed Study Timeline

Estimated Begin Date	Estimated End Date	Task
10/15/11	10/30/11	Prepared survey in electronic format using Zoomerang software.
1/3/12	2/5/12	Prepared and submitted materials for UNLV Institutional Review Boards.
02/5/12	2/15/12	Prepared and submitted materials to the Director for Science, Health, Foreign Language and Physical Education for internal review and approval. Prepared and submitted materials for District Institutional Review Boards.
2/5/12	2/15/12	Sent letter of query to science department coordinators explaining the study and asking for Principal Acknowledgement Forms.
4/5/12	4/15/12	Upon receiving University and District IRB approval, gathered email addresses of teachers with returned Principal's Acknowledgement Forms willing to participate in the study. Sent email thanking potential participants, explained timeline and study responsibilities.
4/15/12		Sent email to participating teachers with reminders to schedule computer time for upcoming survey questionnaire. The district science project facilitator gathered student assent forms and parental permission slips.
4/25/12		Sent email reminder and followed through with participating schools to complete paperwork. The science project facilitator reviewed paperwork and sent out survey link to teachers.
5/01/12	5/30/12	Gathered data. Sent out final reminders and thank you responses. Analyzed student data for demographic consistency. Communicated with advisors.
6/01/12	10/30/12	Analyzed data, wrote survey results and conclusions.

Table 10

Student Self–report of ethnicity

My background is…	N	Girls	Boys	% of N	Study District %
American Indian	5	1	4	0.9	0.6
Asian	46	25	21	9	7.1
Hispanic	165	109	56	32	42.1
African American	28	17	11	5	12.4
White	196	106	90	38	31.8
Pacific Islander	19	11	8	4	1.2
Multi–Race	56	30	26	11	4.7

Table 11

Student Course Enrollment

I am enrolled…	N	%
Biology	291	56
Chemistry	174	34
Physics	0	0
General Science	53	10

Table 12

Content Means by Gender

Content Theme	Cronbach's α	Girls			Boys		
		n	*M*	*SD*	n	*M*	*SD*
Astrophysics, Universe	0.896	292	2.55	0.99	209	2.94	0.96
Earth, Geo–science	0.811	289	2.22	0.93	220	2.32	0.96
Zoology, Animals	0.798	289	2.55	0.98	220	2.59	1.00
Plants, Botany	0.855	285	1.97	0.92	204	2.17	0.97
Chemistry	0.784	289	2.12	0.93	213	2.53	0.91
Light, colors, radiation	0.793	289	2.10	0.95	209	2.51	0.97
Sound	0.607	273	2.30	0.99	201	2.62	0.99
Energy and electricity	0.849	277	2.08	0.92	206	2.62	0.98
Technology	0.814	279	2.17	0.96	206	2.70	0.96
Human Biology	0.946	284	2.71	0.96	208	2.65	0.97

Table 13

T–Test Results: Content Theme by Gender

Content Theme	*t*	*df*	*p*	CI	95% CI		*SED*
					LL	*UL*	
Astrophysics, Universe	4.30	487	<.001	0.39	–0.57	–0.21	.09
Plants, Botany	2.32	487	.02	–0.20	–0.37	–0.03	0.09
Chemistry	4.97	506	<.001	–0.41	–0.57	–0.25	0.08
Light, colors, radiation	3.77	491	<.001	–0.33	–0.50	–0.16	0.09
Sound	2.83	472	.01	–0.26	–0.44	–0.08	0.09
Energy and Electricity	6.25	491	<.001	–0.54	–.071	–0.37	0.09
Technology	6.00	482	<.001	–0.53	–0.70	–0.36	0.09
Zoology, Animals	0.45	507	.65	–0.04	–0.21	0.13	0.09
Human	0.68	490	.50	0.06	0.11	0.23	0.09
Biology							
Earth, Geoscience	1.17	496	1.18	–0.10	–0.27	0.07	0.09

Note. *df* = degrees of freedom; CI = confidence interval; *LL* = lower limit; *UL* = upper limit. *p* values are two–tailed.

Table 14

ANOVA Results for Topics of Interest: Girls by Ethnicity

Girls	*n*	*SS*	*df*	*MS*	*F*	*p*
Universe	292	6.71	(5, 296)	1.34	1.28	.27
Technology	279	3.55	(5, 273)	.71	.74	.60
Energy	277	2.51	(5, 271)	.50	.57	.72
Sound	273	2.53	(5, 267)	.51	.50	.78
Light	289	.55	(5, 283)	.11	.12	.99
Chemistry	289	1.39	(5, 283)	.28	.31	.91
Plants	285	1.96	(5, 279)	.39	.45	.82
Animals	289	4.33	(5, 283)	.87	.83	.53
Geology	289	3.38	(5, 283)	.68	.75	.06
Human Biology	284	9.96	(5, 278)	1.99	2.06	.07

Note. SS = sum of squares; *df* = degrees of freedom; MS = mean of squares; Findings are significant when $p<.05$.

Table 15

ANOVA Results for Topics of Interest: Boys by Ethnicity

Boys	*n*	*SS*	*df*	*MS*	*F*	*p*
Universe	209	1.70	(5, 203)	.34	.35	.89
Technology	205	4.50	(5, 199)	.90	.89	.49
Energy	206	2.57	(5, 198)	.51	.49	.78
Sound	201	3.87	(5, 195)	.74	.76	.58
Light	209	4.99	(5, 203)	.10	1.06	.38
Chemistry	213	2.51	(5, 213)	.50	.55	.74
Plants	204	2.17	(5, 198)	.43	.47	.80
Animals	220	3.23	(5, 214)	.65	.65	.67
Geology	220	3.14	(5, 214)	.63	.68	.64
Human Biology	208	5.13	(5, 202)	1.03	1.13	.35

Note. SS = sum of squares; *df* = degrees of freedom; MS = mean of squares; Findings are significant when $p<.05$.

Table 16

Means: Context Themes by Gender

Context Means	Cronbach's α	*Girls*			Boys		
		n	*M*	*SD*	n	*M*	*SD*
Fitness	0.764	285	2.76	1.02	209	2.31	1.00
Mystery, Philosophy, Wonder, Quasi–science, Belief–oriented	0.855	277	2.77	1.06	197	2.72	1.09
Beauty, aesthetical aspects	0.840	280	2.20	0.98	202	2.20	.98
Environmental protection	0.900	273	2.32	0.97	203	2.50	.88
Hullabaloo, spectacular phenomena, horror	0.805	282	2.4	1.00	205	2.66	.98
Relevance, Everyday use	0.854	273	2.26	0.94	195	2.23	.96
Issues relevant to Youth	0.860	274	2.58	1.03	199	2.75	1.03
STS; Nature of Science	0.817	282	2.06	0.89	213	2.55	.95

Table 17

T–Test Results of Means Context Theme by Gender

Context Theme	*t*	*df*	*p*	CI	95% CI		*SED*
					LL	*UL*	
Fitness	4.89	492	<.001	0.27	0.63	0.45	0.09
Mystery, Philosophy, Quasi–science	2.60	472	.01	–0.46	–0.06	–0.26	0.10
Beauty, aesthetical aspects	.00	480	1.00	0.00	–0.18	–0.18	0.09
Environmental Protection	2.08	474	.04	0.35	–0.01	–0.18	0.09
Hullabaloo, Spectacular Phenomena	2.86	485	.004	–0.44	–0.08	–0.26	0.09
Relevance, Everyday use	0.34	466	0.74	–0.15	0.20	0.03	0.09
Issues Related to Youth	1.77	471	0.08	–0.36	0.02	–0.17	0.10
Science, Technology and Science, Nature of Science	5.89	493	<.001	–0.65	–0.33	–0.49	0.08

Note. *df* = degrees of freedom; CI = confidence interval; *LL* = lower limit; *UL* = upper limit. *p* are two–tailed. Findings are statistically significant at p<.05.

Table 18

Ethnicity Profiles Boys: High and Low Interests

Ethnicity/Boys	Highest Interests	Lowest Interests
African American	Astrophysics, Universe Issues relevant to youth Human biology	Plants, Botany Technology Relevance, Everyday topics
Asian	Technology Astrophysics, Universe Mystery	Beauty, aesthetical Plants, Botany Earth, Geo–science
Hispanic	Astrophysics, Universe Mystery Technology	Beauty, aesthetical Plants, Botany Relevance, Everyday topics
Multi–race	Astrophysics, Universe Mystery Technology	Plants, Botany Beauty, aesthetical Relevance, Everyday topics
Pacific Islander	Astrophysics, Universe Mystery Issues relevant to youth	Relevance, Everyday topics Beauty, aesthetical Plants, Botany
White	Astrophysics, Universe Mystery Technology	Plants, Botany Fitness Relevance, Everyday topics

Table 19

Ethnicity Profiles Girls: High and Low Interests

Ethnicity/Girls	Highest Interests	Lowest Interests
African American	Fitness Human biology Issues relevant to youth	Energy and Electricity Plants, Botany Science, Technology and Society
Asian	Mystery Human biology Astrophysics, Universe	Relevance, Everyday topics Chemistry Plants, Botany
Hispanic	Mystery Fitness Human biology	Plants, Botany Relevance, Everyday topics Science, Technology and Society
Multi–race	Fitness Mystery Human biology	Science, Technology and Society Energy and Electricity Relevance, Everyday topics
Pacific Islander	Fitness Human biology Issues relevant to youth	Relevance, Everyday topics Science, Technology and Society Plants, Botany
White	Mystery Fitness Zoology, Animals	Environmental Protection Relevance, Everyday topics Plants, Botany

Table 20

School Science Experience: Means by Gender

Case	Cronbach's α	*Girls*			Boys		
		n	*M*	*SD*	n	*M*	*SD*
School Science is Interesting	0.881	277	2.41	1.07	199	2.60	1.10
School Science Will Influence my Career Choice	0.784	272	2.05	1.08	199	2.39	1.12
School Science is Practical	0.826	242	2.52	1.10	197	2.67	1.11

Table 21

T–Test Summary: School Science Experience by Gender

Case	*t*	*df*	*p*	CI	95% CI		*SED*
					LL	*UL*	
School Science is Interesting	1.89	474	0.06	–0.19	–0.39	0.01	.10
School Science Will Influence my Career Choice	3.32	469	<.001	–0.34	–0.54	–0.14	.10
School Science is Practical	1.42	437	0.16	0.35	–0.1	–0.36	.11

Note. *df* = degrees of freedom; CI = confidence interval; *LL* = lower limit; *UL* = upper limit. *p* values are two–tailed. Findings are statistically significant at p<.05.

Table 22

ANOVA results: School Science Experience by Ethnicity

Girls	*n*	*SS*	*df*	*MS*	*F*	*p*
School Science is Interesting	277	5.01	(5, 270)	1.00	0.89	0.49
School Science Influences Career Choice	272	2.19	(5, 265)	.44	0.38	0.86
School Science is Practical	242	7.63	(5, 266)	1.51	1.29	0.27

Note. SS = sum of squares; *df* = degree of freedom; *MS* = mean of squares.

Table 23

ANOVA results: School Science is Interesting by Boys/Ethnicity

Boys	n	SS	*df*	MS	F	*p*
School Science is Interesting	199	6.39	(5, 191)	1.28	1.06	0.38
School Science Influences Career Choice	199	5.05	(5, 192)	1.01	0.82	0.54
School Science is Practical	197	3.44	(5, 191)	0.69	0.60	0.70

Note. n varies due to voluntary nature of survey. *SS* = sum of squares; *df* = degree of freedom; *MS* = mean of squares.

Table 24

My Future Job: Means Boys and Girls by High Interest Item

High Interest Items	Girls	Boys
	Means (SD)	Means (SD)
Working with something that fits my attitudes and values	3.37 (.82)	3.34 (.81)
Working with something I find important and meaningful	3.51 (.73)	3.35 (.80)
Making my own decisions	3.43 (.74)	3.43 (.74)
Using my talents and abilities	3.36 (.88)	3.39 (.84)
Developing or improving my knowledge and abilities	3.39 (.78)	3.27 (.84)
Helping other people	3.37 (.82)	2.29 (.90)
Earning lots of money	3.10 (.92)	3.34 (.89)
Having lots of time for my family	3.24 (.83)	3.15 (.88)
Working as part of a team with many people around me	3.00 (.85)	3.05 (.88)

Table 25

My Future Job: Means Boys and Girls by Low Interest Item

Low Interest Items	Girls	Boys
	Means (SD)	Means (SD)
Building or repairing objects using my hands	2.12 (.97)	2.69 (1.02)
Working with something easy and simple	2.33 (.93)	2.38 (.100)
Working in the area of environmental protection	2.38 (1.03)	2.33 (1.05)
Working with animals	2.41 (1.15)	2.20 (1.01)
Becoming famous	1.89 (1.03)	2.23 (1.18)
Controlling other people	1.86 (.91)	2.11 (1.01)

Table 26

ROSE Career items

Rose Career Items	Girls		Boys	
	N	Means (SD)	N	Means (SD)
School science has opened my eyes to new and exciting jobs	269	2.24 (1.15)	199	2.40 (1.12)
I think that the science I learn at school will improve my career chances	272	2.60 (1.15)	196	2.71 (1.14)
School science has shown me the importance of science for our way of living	272	2.62 (1.09)	194	2.80 (1.11)
I would like to get a job in technology	272	1.80 (1.02)	197	2.81 (1.12)
I would like to become a scientist	273	1.66 (.99)	195	1.79 (1.04)

References

Achieve, Inc. (2012). Draft Next Generation Science Standards. Retrieved from http://www.nextgenscience.org/.

Aikenhead, G. (1996). Science Education: Border crossing into the sub-culture of science. *Studies in Science Education, 27*, 1–52.

Aikenhead, G. (2000). Renegotiating the culture of school science. In R. Millar, J. Leach, & J. Osborne (Eds.) *Improving Science Education: The Contribution of Research* (pp. 1-366). Open University Press.

Aikenhead, G. (2004). Science-based occupations and the science curriculum: Concepts of evidence. *Science Education, 89*(2), 242–275.

Allal, L. (2001). Situated cognition and learning: From conceptual frameworks to classroom investigations. *Schweizerische Zeitscrift fur Bildungswissenschaften 23*(3), 407–422.

Anderson, R. D. (2006). *Inquiry as an organizing theme for science curricula*. In S. K. Abell & N. G. Lederman (Eds.) *Handbook of research on science education* (pp. 807–830). Lawrence Erlbaum Associates, London.

Apple Classrooms of Tomorrow 2. Relevant and applied curriculum. Retrieved from http://ali.apple.com/acot2/.

Aschbacher, P. R., Li, E., & Roth, E. J. (2009). Is science me? High school students' identities, participation and aspirations in science, engineering and medicine. *Journal of Research in Science Teaching, 47*(5), 564–582.

Aud, S., Hussar, W., Johnson, F., Kena, G., & Roth, E. (2012). The condition of education 2012. *National Center for Educational Statistics*. Retrieved from

Baker, D. (2005). Global trends in educational policy. *International Perspectives on Education and Society, 6*, 1–21.

Bandura, A. (1994). Self–efficacy. In V. S. Ramachaudran (Ed.), *Encyclopedia of human behavior* (Vol. 4), (pp.71–81). New York: Academic Press.

Barton, A. C. (1998). Reframing "Science for All" through the politics of poverty. *Education Policy, 12*(5), 525–541.

Basu, S. J., & Barton, A. C. (2005). Developing a sustained interest in science among urban minority youth. *Journal of Research in Science Teaching, 44*(3), 466–489.

Beier, M., & Rittmayer, A. (2008). Literature overview: Motivational Factors in STEM: Interest and self-concept. Retrieved from http://www.AWEonline.org.

Bell, P., Lewenstein, B., Shouse, A., & Feder, M. (2009). *Learning science in informal environments*. Washington DC: National Academies Press.

Bennett, J., Lubben, F., & Hograth, S. (2007). Bringing science to life: A synthesis of the research evidence on the effects of context-based and STS approaches to science teaching. *Science Education, 91*(3), 347-370.

Blank, R. K. (2012). What is the impact of NCLB on science achievement? *Noyce Foundation*, 1–15.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated learning and the culture of learning. *Educational Researcher 18*(1), 32–42.

Bybee, R. (1997). Toward an understanding of scientific literacy. In W. Graber & C. Bolte (Eds.), Scientific literacy, (pp. 37–68). Kiel, Germany: Institute for Science Education.

Bybee, R., & McCrae, B. (2011). Scientific literacy and student attitudes: Perspectives

from PISA 2006 science. *International Journal of Science Education*, *33*(1), 7–26.

Change the equation, (2011). Vital Signs Study State. Retrieved from http://changetheequation.org/sites/default/files/vital-pdfs/ST-CTEq-vital-signs.pdf.

Charney, J., Hmelo-Silver, C., Sofer, W., Neigeborn, L., Coletta, S., & Nemeroff, M. (2007). Cognitive apprenticeship in science through immersion in laboratory practices. *International Journal of Science Education, 29*(2), 195-213.

Cataldi, E., & Ramani, A. K. (2009). High School Dropout and Completion Rates in the United States: 2007 Compendium Report. *National Center for Educational Statistics*. Retrieved from http://www.eric.ed.gov/ERICWebPortal/search/detailmini.jsp?_nfpb=true&_&ERICExtSearch_SearchValue_0=ED506561&ERICExtSearch_SearchType_0=no&accno=ED506561.

DeBoer, G. (2000). Scientific literacy: Another look at its historical and contemporary meanings and its relationship to science education reform. *Journal of Research in Science Teaching, 37*(6), 582-601.

DeBoer, G. E. (2010). How state and federal policy affects what is taught in science classes. In G. E. DeBoer (Ed.). *The role of public policy in K–12 science education* (pp. 275–303). Charlotte, NC: Information Age Publishing.

DeBoer, G. (2011). The globalization of science education. *Journal of Research in Science Teaching, 48*(6), 567-591.

Dewitt, J., Archer, L., Obsorne, J., Dillon, J., Willis, B., & Wong, B. (2010). High

aspirations but low progression: The science aspirations-careers paradox amongst minority ethnic students. *International Journal of Science and Mathematics Education, 94*(4), 617–639.

Dillman, D. A. (2007). *Mail and internet surveys: The tailored design method* (Second ed.). New York: Wiley.

Duschl, R. (2008). Science education in three–part harmony: Balancing conceptual, epistemic, and social learning goals. *Review of Research in Education* 32(1), 268–291.

Duschl, R., Schweingruber, H. A., & Shouse, A. W. (2007). *Taking science to school*. Washington, D.C. The National Academies Press.

Elster, D. (2007). Student interests – the German and Austrian ROSE survey. *Journal of*

Fensham, P. J. (1999). School science and public understanding of science. *International Journal of Science Education*, 21(7), 755–763.

George, R. (2007). A cross–domain analysis of change in students' attitudes toward science and attitudes about the utility of science. *International Journal of Science Education, 28*(6), 571–589.

Ghosh, R., Mickelson, R., & Anyon, J. (2007). Introduction to the special issue on new perspectives on youth development and social identity in the 21st century. *Teachers College Record, 109*(2), 275-284.

Haste, H. (2004). Science in my future. *Nestle' Social Research Programme*, 1, 1–29.

Hazari, Z., Sonnert, G., Sadler, P., & Shanahan, M. (2010). Connecting high school

physics experiences, outcome expectations, physics identity, physics career choice: A gender study. *Journal of Research in Science Teaching, 47*(8), 978–1003.

Hmelo, C. E, & Evensen, D. H. (2000). PBL: Gaining insights on learning interactions through multiple methods of inquiry. In Evensen DH, Hmelo CE. (Eds.), *Problem-based Learning, A Research Perspective on Learning Interactions,* (pp.1–16). Mahwah, NJ: L. Erlbaum Associates.

Henrichsen, L., Smith, M., & Baker, D. (1996). Retrieved from http://linguistics.byu.edu/faculty/henrichsenl/ResearchMethods/index.html.

Hogrebe, M. C., & Tate, W. F. (2010). School composition and context factors that moderate and predict 10th–grade science proficiency. *Teachers College Record, 112*(4), 1096–1136.

Holbrook, J., & Rannikmae, M. (2009). The meaning of scientific literacy. *International Journal of Environmental & Science Education, 4*(3), 275–288.

Hurd, P. D. (2001). Modernizing Science Education. *Journal of Research in Science Teaching, 39*(1), 3–9.

Jan, M., San, C. Y., & Tan, E. M. (2011). Reconceptualizing science classroom discourse towards doing science through a game–based learning program. *US-China Education Review*, 786–796.

Jenkins, E. W. (2006). The student voice and school science education. *Studies in Science Education*, 42, 49–88.

Jidesjo, A., Oscarsson, M., Karlsson, K. G., & Stromdahl, H. (2009). Science for all or

science for some: What Swedish students want to learn about in secondary science and technology and their opinions on science lessons. *Nordic Studies in Science Education*, 5(2), 213–229.

Johri, A., & Olds, B. (2011). Situated engineering learning: Bridging engineering education research and the learning sciences. *Journal of Engineering Education, 100*(1), 151-185.

Krajcik, J. S., M.Czerniak, C., & Berger, C. F. (2003). *Teaching science in elementary and middle school classrooms: A project–based approach* (2nd ed.). New York: McGraw–Hill.

Krosnick, J. (1999). Survey Research. *Annual Review of Psychology, 50*, 537–567.

Lave, J., & Wenger, E. (1991). *Situated learning*. New York: Cambridge University Press.

Lavonen, J., Gedrovics, J., Byman, R., Meisalo, V., Juuti, K., & Uitto, A. (2008). Students' motivational orientations and career choice in science and technology: A comparative investigation in Finland and Latvia. *Journal of Baltic Science Education*, 7(2), 86–102.

Laugksch, R. C. (1999). Scientific literacy: A conceptual overview. *Science Education, 84*(1), 71–94.

Lee, O. (2005). Science education with English language learners: Synthesis and research agenda. *Review of Educational Research, 75*(4), 491–530.

Lee, O. (2011). Effective STEM education strategies for diverse and underserved learners. Retrieved from http://www.wastatelaser.org/_events/stem/docs/5-Effective-Practices/Lee-2011-Effective-STEM-practices-for-diverse-learners.pdf.

Lee, O., & Buxton, C. (2010). Diversity and equity in science education: Research, policy and practice. New York: Teachers College Press.

Lee, O., & Fradd, S. (1998). Science for all, including students from non–English–language backgrounds. *Educational Researcher, 27*(4), 12–21.

Lynch, S. (2010). Equity and the U.S. science education policy from the GI Bill to NCLB: From opportunity denied to mandated outcomes. In G. E. DeBoer (Ed.), *The role of public policy in K–12 science education* (pp.77–116). Charlotte, NC: Information Age Publishing.

Mathews, Jay. (2011). Class struggle. Myth of the declining U.S. schools. Retrieved from http://voices.washingtonpost.com/classstruggle/2011/02/myth_of_declining_us_schools.html.

Millar, R., & Osborne, J. (1998). Beyond 2000: Science education for the future. *Kings College*, London, 1–31. Retrieved from http://www.kcl.ac.uk/education.

Modi, K., Schoenberg, J., & Salmond, K. (2012). Generation STEM: What girls say about science, technology, engineering and math. New York: Girl Scouts Research Institute.

National Assessment of Educational Progress (2010). *Classroom context: Time spent on science instruction*. Retrieved from http://www.nationsreportcard.gov/science_2009/context_5.asp.

National Assessment of Educational Progress (2009). *Science framework for the 2009 national assessment of educational progress*. Washington, DC.

National Research Council (1996). *National science education standards*. Washington, DC: National Academy Press.

National Research Council (2007). *Taking science to school: Learning and teaching science in grades K–8*. Washington, DC: National Academy Press.

National Research Council (2011). Successful STEM education: A workshop summary. Committee on highly successful schools for K-12 STEM education, *Board on Science Education and Board on Testing and Assessment*, Washington, DC: National Academy Press.

National Research Council (2011). *A Framework for K-12 Science Education*. Washington, DC: National Academy Press.

Ogawa, M. (2006) Even science lovers do not want to become scientists or engineers: From ROSE data in Japan. *CONNECT (UNESCO)* 31, pp. 5–9. Retrieved from http://unesdoc.unesco.org/images/0014/001469/146976e.pdf.

Ogawa, M. & Shimode, S. (2004) Three distinctive groups among Japanese students in terms of their school science preference: from preliminary analysis of Japanese date of an international survey "the Relevance of Science Education" (ROSE). *Journal of Science Education in Japan,* 28(4), 279–291.

Organization for Economic Cooperation and Development (2006). Evolution of student interest in science and technology studies policy report (pp. 1-18). Paris: OECD.

Orgill, M. (2007). Situated Cognition. In G. M. Bodner & M. Orgill (Eds.), *Theoretical frameworks for research in chemistry/science education*. Upper Saddle Hill River, NJ: Prentice Hall.

Osborne, J. (2007). Science education for the twenty–first century. *Eurasia Journal of Mathematics, Science & Technology Education*, 3(3), 173–184.

Osborne, J. (2010). Science education policy and its relationship with research and

practice: Lessons from Europe and the United Kingdom. In G. E. DeBoer (Ed.), *The role of public policy in K–12 science education* (pp.13–46). Charlotte, NC: Information Age Publishing.

Osborne, J. & Collins, S. (2001) Pupil's views of the role and value of the science curriculum: A focus–group study. *International Journal of Science Education*, 23(5), 441–467.

Osborne, J., Simon, S. & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education,* 25(9), 1049–1079.

Osborne, J., & Dillon, J. (2008). *Science education in Europe: Critical reflections*. London: The Nuffield Foundation.

Osborne, J., Simon, S. Collins, S., Ratcliffe, M., Millar, R., & Duschl, R. (2003). What "Ideas–about–science" should be taught in school science? A Delphi study of the expert community. *Journal of Research in Science Teaching,* 40(7), 692–720.

Oscarsson, M., Jidesjo, A., Stromdahl, H., & Karlsson, & K. G., (2009). Science in society or science in school: Swedish secondary school teachers' beliefs about science and science lessons in comparison with what students want to learn. *Nordic Studies in Science Education*, 5(1), 18–34.

Quinn, H., Lee, O., & Valdes, G. (2012). Language demands and opportunities in relation to Next Generation Science Standards for English language learners: What teachers need to know. *Understanding Language*, 1–12. Retrieved from http://connect.nwp.org/sites/default/files/file_file/03-quinn_lee_valdes_language_and_opportunities_in_science_final.pdf.

Roberts, D. A. (2007). Scientific literacy/Science Literacy. In S. K. Abell & N. G. Lederman (Eds.) *Handbook of research on science education* (pp.829–780). Lawrence Erlbaum Associates, London.

Roth, W., & Lee, S. (2003). Science education as for participation in the community. *Science Education, 88*(2), 263–291.

Sadler, T. (2009). Situated learning in science education: Socio–scientific issues as contexts for practice. *Studies in Science Education, 45*(1), 1–42.

Sadler, T. D., Burgin, S., McKinney, L., & Ponjuan, L. (2010). Learning science through research apprenticeships: A critical review of the literature. *Journal of Research in Science Teaching, 47*(3), 235-256.

Sadler, T. D., & Zeidler, D. L. (2009). Scientific literacy, PISA and socio–scientific discourse: Assessment for progressive aims of science education. *Journal of Research in Science Teaching, 46*(8), 909-921.

Schreiner, C. (2006). *Exploring a ROSE garden.* (Doctor Scientiarum), University of Oslo, Oslo. (58).

Schreiner, C. and Sjoberg, S. (2004). *Sowing the seeds of ROSE. Background, rationale, questionnaire development and data collection for ROSE (The Relevance of Science Education)—A comparative study of students' views of science and science education*, University of Oslo, Oslo.

Seiler, G. (2001). Reversing the "standard" direction: Science emerging from the lives of African American students. *Journal of Research in Science Teaching, 38*(9), 1000–1014.

Seiler, G. (2011). Reconstructing science curricula through student voice and choice.

Education and Urban Society, XX(X), 1–23.

Settlage, J., & Meadows, L. (2001). Standards-based reform and its unintended consequences: Implication for science education within America's urban schools. *Journal of Research in Science Teaching, 39*(2), 114–127.

Shultz, K. S., & Whitney, D. J. (2005). *Measurement theory in action – Case studies and exercises*. Thousand Oaks, CA: Sage.

Simpson, R., & Oliver, J. S. (1990). A summary of major influences on attitude toward and achievement in science among adolescent students. *Science Education, 74*(1), 1–18.

Sjoberg, S. (2000). Science and scientists: The SAS study. Retrieved from http://scholar.googleusercontent.com/scholar?q=cache:u2Kh01E6aQcJ:scholar.google.com/+sjoberg+2000+science+education&hl=en&as_sdt=0,48.

Sjoberg, S. (2005). Proceedings from at the EU's Science and Society Forum: *Young people and science: Attitudes, values and priorities. Evidence from the ROSE project*. Brussels, Belgium.

Sjoberg, S., & Schreiner, C. (2002). ROSE handbook: Introduction, guidelines and underlying ideas. Retrieved from http://www.ils.uio.no/forskning/rose/documents/ROSE%20handbook.htm#_Toc28682830.

Sjoberg, S., & Schreiner, C. (2010). The ROSE project: An overview and key findings, 1–31. Retrieved from http://eacea.ec.eruopa.eu/education/eurydice/.

Sjoberg, S., & Schreiner, C. (2010). The ROSE project: An overview and key findings.

Retrieved from http://traces.fisica.unina.it/attachments/article/168/ROSE-Sjoberg-Schreiner-overview-2010-1.pdf.

State Accountability Report (2011). Retrieved from http://www.statereportcard.com/.

State Report Card (2012). Retrieved from http://www.statereportcard.com/.

Study School District. (2007). Regulation 5127. Retrieved from http://studyschooldistrict.net/district/policies-regulations/pdf/5127_R.pdf.

Study School District. (2010). Monitoring Report. Retrieved from http://studyschooldistrict.net/district/policies-regulations/pdf/5127_R.pdf.

Study School District. (2010). Growth model. Retrieved from http://studyschooldistrict.net/district/growth-model/.

Study School District. (2010). Demographics. Retrieved from http://studyschooldistrict.net/schools/pdf/acc_pdfs_2011/2010-2011_District_Accountability_Report.pdf.

Study School District. (2012). Response to Instruction. Retrieved from http://www.studyschooldistrict.net/parents/response-instruction/.

Swarat, S., Ortony, A., & Revelle, W. (2012). Activity matters: Understanding student interest in school science. *Journal of Research in Science Teaching, 49*(4), 515–537.

Tate, E. D., Linn, M. C., Clark, D., Gallagher, J. J., & McLaughlin, D. (2008). Designing Science Instruction for Diverse Learners. In Y. Kali, M. C. Linn & J. C. Roseman (Eds.), Designing Coherent Science Instruction (pp. 65-93). New York, NY: Teachers College Press.

Tate, W. (2001). Science education as a civil right: Urban schools and opportunity-to-

learn considerations. *Journal of Research in Science Teaching, 38*(9), 1015-1028.

Tate, W. (2008). "Geography of Opportunity:" Poverty, place and educational outcomes. *Educational Researcher, 37*(7), 397–411.

UNESCO (2004). Declaration of Amsterdam on the right to and the rights in education. Retrieved from http://unesdoc.unesco.org/images/0014/001471/147101e.pdf.

UNESCO (2009). Current challenges in basic science education. Retrieved from http://unesdoc.unesco.org/images/0019/001914/191425e.pdf.

U. S. Department of Education (2001). *No Child Left Behind Act of 2001*. Retrieved from http://www.ed.gov/policy/elsec/leg/esea02/index.html.

Williams, C., Stanisstreet, M., Spall, K., Boyes, E., & Dickson, D. (2003). Why aren't secondary students interested in physics? *Physics Education, 38*(4), 324-329.

Wink, D. (2010). Using rigor and relevance to address dropouts in the science classroom. *Chemical Education Today, 87*(11), 1119.

Yager, R., & Yager, S. O. (1985). Changes in perceptions of science in third, seventh, and eleventh grade students. *Journal of Research in Science Teaching, 22*(4), 347–358.

Yao, K. (1985). Science in the culture of our times: Implications for education. *CUHK Education Journal*,13(2), 62–70.

Yonezawa, S., Jones, M., & Joselowsky, F. (2009). Youth engagement in high schools: Developing a multidimensional, critical approach to improving engagement for all students. *Journal of Educational Change, 10*, 191–209.

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Ebert, E. K, Crippen, K.J. (2009). The centrality of inquiry for teaching and learning science. In R. E. Yager (Ed.),Inquiry: The key to exemplary science: Vol. 6. Arlington: NSTA Press.

Ebert, E. K. Using Depth of Knowledge in Science Lessons, *Shop Talk, Winter Edition*, 2009.

Goals, Guidelines, and Standards for Student Scientific Investigations. *North American Council for Online Learning*. (2008) contributing committee member. http://www.inacol.org/research/docs/NACOL_ScienceStandards_web.pdf.

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