Increasing Student Awareness of STEM Careers in High School Science Classes

Stuart Surrey
Philadelphia High School for Girls

Introduction

As we move into the twenty-first century, careers in science, technology, engineering and mathematics (STEM) are becoming increasingly more important. Therefore, a greater number of students with undergraduate and/or graduate level university degrees in these areas will be required to fill the numerous and varied professional opportunities which are currently being developed in these disciplines. However, there is a great disparity among the student populations entering collegiate science programs. At the present time, an increasing number of colleges and universities across the country are actively recruiting students and in particular students from traditionally under-represented populations. This curriculum unit has been designed to introduce high school environmental science students into the field of robotics. The ultimate goal of the unit is to motivate minority student populations into considering STEM as a career path.

Student Demographics

Founded in 1848, the Philadelphia High School for Girls is a college preparatory, special admit high school. It is also the only single sex public school in the city of Philadelphia. The enrollment consists of approximately 1,100 female students in grades 9 through 12. The breakdown of this culturally diverse student population is as follows: 66 percent of the students are African American, 16.6 percent are Asian, 8.7 percent are Latino, 7.7 percent are Caucasian, and 1.0 percent is listed as other. The admission requirements for the students include: scoring above the 85th percentile on standardized tests, and receiving scholastic grades of all A's and B's with no more than one C. In addition, the students must have good attendance and behavior records.

Objectives

The main objective of this curriculum unit is to increase student awareness of science, technology, engineering, and mathematics (STEM) careers among female high school juniors enrolled in environmental science. With the aid of computer programming and engineering skills applicable to robotics, the students will engage in a number of activities designed to introduce them to various STEM careers. The unit is designed to be incorporated into chapter two, "Scientific Methods", of the Environmental Science curriculum. It is aligned to both the Pennsylvania Common Core Standards and the Next Generation Science Standards. A positive outcome of this unit would be an increase in the number of traditionally underrepresented student populations applying to collegiate science and/or engineering programs.

Rationale

Major concerns regarding the quality of education in the United States date back at least thirty years. The U. S. Secretary of Education in 1981, T. H. Bell, established the National Commission on Excellence in Education arising from public concern regarding the state of education in the United States. The commission which was composed of eighteen members published their findings less than two years later in a report entitled "A Nation at Risk: The Imperative for Educational Reform". That report delineated numerous deficiencies, shortcomings and concerns with regard to the educational system in the United States. The commission was able to classify the concerns into "four main aspects of the educational process" which included: content, expectations, time, and teaching. There are two principal points of interest from that report that are relevant to this unit. The first concern deals with content and the decrease in the number of higher level courses offered at the secondary level. The second concern deals with the declining results on standardized tests (1).

Thirty years after its publication, Edward Graham wrote an article entitled "A Nation at Risk Turns 30: Where Did It Take Us?" He points out that other than the adoption of the Common Core State Standards by an overwhelming number of states across the country, very little, if anything, has resulted from that report. Among today's problems facing urban and suburban school districts alike from coast to coast are: budgetary difficulties, standardized testing, limited creativity and a decrease in the number of after school remedial programs. In that article, National Education Association (NEA) president, Dennis Van Roekel, was quoted as saying, "Educators across the country work hard to give their students the great education they deserve, but lawmakers cannot keep pulling the rug out from under them with bad ideas. We need to do what we know works. We need to fully fund our schools, invest in early childhood education, increase parental involvement and keep our class sizes small, especially in high-poverty schools at the lower grades. This is how we'll make our schools work for every student." (2).

Adoption of the Common Core Standards, by the state of Pennsylvania, has led to a number of changes in the academic standards for English language arts and mathematics.in all grades throughout the state. Emphasis is largely devoted to college and career readiness by improving critical thinking skills in reading, writing and mathematics (3). In addition, the Next Generation Science Standards (NGSS) involves a number of fundamental improvements to science education throughout the United States. Among the numerous recommendations proposed, the NGSS advocates student engagement in science and engineering practices. Furthermore, the NGSS goes on to state that in order to understand engineering, students must be able to combine content knowledge with the ability to conduct scientific inquiry utilizing engineering design processes (4).

Personal observations as a high school science teacher spanning a twenty-nine year career with the School District of Philadelphia has led to the conclusion that academic achievement in the sciences, whether that be in the life sciences or the physical sciences, is directly related to a student's ability to read and comprehend grade level informational text. High school students enrolled in the School District of Philadelphia generally score below grade level on standardized tests in reading and science. Most of the reading deficiencies are related to nonfiction, informational text. Scholastic achievement in the sciences and mathematics, among public school students across the country, continues to lag far behind those in many other countries from around the world. Results from the 2012 Programme for International Student Assessment (PISA) indicate that fifteen year old students from the United States rank twenty-first in science and twenty-sixth in mathematics out of the thirty-four Organisation for Economic Co-operation and Development (OECD) countries participating (5). Currently, there is a concerted effort across the country to increase the number of minorities and underrepresented student populations into collegiate STEM programs. The proposed curriculum unit will research the underlying reasons associated with the disparity between gender and ethnicity among high school students enrolled in collegiate STEM programs as well as a number of activities designed to increase interest in computer programming and engineering.

Background Information

This particular section has been divided into two distinct areas. The first focuses on specific factors associated with the lack of participation by under-represented student populations in collegiate STEM programs. Before proceeding, the term "under-represented student populations" is specifically meant to include: African-American, Hispanic, Latino, Native-American and female students. The second section, however, is designed to examine the classroom use of robotics.

Under-represented Student Populations in Collegiate STEM Programs

The lack of student participation by specific ethnic and gender populations in STEM programs is a major concern currently facing American society. In a 2005 article focusing on women and minorities in STEM programs, the demographics of all the undergraduate engineering students in the United States was reported according to the American Society of Engineering Education (ASEE). According to that report, white students accounted for 68% of the population. Asian-American students accounted for 14%, and both Hispanic and African-American students both represented approximately 5% of the population. They also stated that while female students represented 20% of the students enrolled in collegiate engineering programs, they only account for about 9% of those active in the engineering profession (6). The root causes for the gender and ethnic disparity appear to be as numerous as they are varied. Studies have focused on societal concerns as well as academic achievement. The following articles are intended to be an overview, and by no means an exhaustive study, on the controversy surrounding the lack of minorities and women in collegiate STEM programs.

In 2007, several researchers from the University of South Florida examined the relationship between high school level science and math courses to the completion of a baccalaureate degree in a STEM program. The authors acknowledged that this study focused on only those students who graduated from a Florida, four-year public university and not from any private university within Florida. The study also did not include any data for those students graduating from public or private universities outside of Florida. Even so this study offers some relevant information regarding the racial and gender gap pervasive in collegiate STEM programs. The study examined approximately 94,000 students who graduated from over 350 public high schools in the state of Florida from 1996 to 1997. The results were part of the Florida Longitudinal Education and Employment Dataset collected under the auspices of the Florida Department of Education. That dataset included statistics on: high school level course preferences, scholastic performance, collegiate enrollment and employment, and graduate level enrollment and employment within the state of Florida up to and including the 2003 to 2004 academic year. In their article entitled *Science, Technology, Engineering, and Mathematics (STEM) Pathways: High School Science and Math Coursework and Postsecondary Degree Attainment*, the authors examined the following three questions:

1. "What levels of high school science and mathematics course-taking are related to future STEM baccalaureate degree attainment among all degree recipients?"
2. "How do students of different race, class, and gender groups differ in science and mathematics course-taking levels?"
3. "How does high school course-taking account for these disparities in STEM attainment?"

Based on their study, the authors concluded that attainment of a collegiate degree in a STEM field is largely dependent upon the completion of higher level math and science courses at the high school level and in particular: calculus and physics. Their recommendation to both school districts and individual schools alike is: "…it is critically important that schools find ways to offer opportunities for all students to enroll in the highest level courses in mathematics and science, for if they do, students taking these courses are more likely to persist in the STEM pathway regardless of race or ethnicity." (7)

Another study conducted in 2007 by researchers at the University of Southern California, examined the academic success of Latino students enrolled in a STEM major. Their guiding research questions were:

1. "To what extent does cultural capital and cultural congruity affect the academic performance of Latino students' majoring in STEM fields?"
2. "To what extent does campus climate, as measured through academic-related experiences of Latino students in STEM majors affect their academic performance?"

Before proceeding with their results, it would be prudent to explain the differences between the terms "cultural capital" and "cultural congruity". Regarding the former term, cultural capital, the authors take into account the viewpoints from a number of other researchers. They go on to state that cultural capital involves among other factors: "the socialization into cultural activities such as reading literature, listening to classical music and attending museums and theaters", "…the familiarity and ease with which one navigates the dominant culture of society.", and "…requires a gained predisposed cultural competence gained through family upbringing." Since many of the parents of Latino students have only attended high school, a number of other researchers have concluded that compared to students whose parents attended college the cultural capital of Latino students is quite different. As for the second term, "cultural congruity", this simply refers to the relationship between one's socioeconomic level and the environments of middle-class universities.

Even though the results of this study were obtained from a rather small sample size (n=146) and the majority of the students were from private colleges or universities, there are several important outcomes. The authors largely attribute success in collegiate STEM majors to high GPA scores in high school, however they recommend that an increase in STEM related high school-to-college programs is needed as a means improving the academic performance among minority students. They also reported that the cultural capital of the students did not significantly impact their collegiate GPA. The cultural incongruity encountered by Latino students did have a negative impact on their overall GPA. Among the final conclusions to this study was the recommendation that: "To enhance Latino student's GPAs, educators must continue to develop strategies that promote long-term and intellectually challenging student-faculty interactions." (8)

In 2007, Lisa Tsui published a literature review article focusing on successful strategies intended to increase the diversity in STEM fields. Although many of the references included in this review may be considered dated, the concerns continue to be relevant in 2014. In that article, the lack of minorities and women in STEM programs was largely attributed to a variety of socioeconomic factors. The author's intent was not to delve into the root causes for the disparity in STEM populations. On the contrary, her goal was to examine strategies which are commonly used to increase the number of under-represented student populations into collegiate STEM programs. A brief description of each of those strategies is given below.

- Summer Bridge: This type of program primarily targets low-income minority high school students. Most of these high school-to-college transition programs include a variety of academically intense enrichment curricula and/or activities. The necessity for these programs, in general, arises from a lack of minority students enrolled in advanced placement or higher level mathematics and/or science courses in high school.
- Mentoring: The success of a mentoring program can be related to the type of program one establishes. A mentoring program can be classified as being formal or informal. According to the article, informal mentoring programs tend to be more successful than formal ones. The importance of the ethnicity, race, and/or gender of the mentor appears to be controversial. Whereas some studies tend to support their importance, others suggest that knowledge of the academic discipline is paramount.
- Research Experience: A number of reports cited in the article acknowledged that the ability to participate in academic or industrial research projects had numerous positive effects on the students, including but not limited to: improving one's self-esteem, assisting in collegiate retention, as well as enhancing one's interest in science and engineering. This type of program can also be the source of an effective mentoring relationship.
- Tutoring: Successful programs need not exclusively involve faculty members as the tutors. As noted in the article, "Most studies that compare achievement outcomes of students tutored by either peers or staff members have found no differences." Additionally, a number of studies have shown that peer tutoring can be of benefit to both the student being tutored as well as the student doing the tutoring.
- Career Counseling and Awareness: A number of studies have been included in this rather extensive review article that have revealed an inverse relationship between one's socioeconomic status and their career counseling while in high school. Based on previous studies, the author stated, "The lack of early encouragement and motivation has been identified as one of the main reasons for the under-representation of African-American students in the natural sciences."
- Learning Center: Collegiate learning centers represent on-campus facilities designed to improve student achievement by providing such services as: study areas, interactive activities, tutoring services, access to computer labs, and test review materials.
- Workshops and Seminars: This is another collegiate level program designed to improve academic achievement by providing aid in study, reading, test taking, ad time-management skills. Minority students in particular experience difficulty in one or more of these areas at the collegiate level.

- Academic Advising: Access to quality academic advisors at the collegiate level has been reported to be integral in the retention of students in STEM majors especially among minority and female students.
- Financial Support: Under-represented populations in collegiate STEM programs tend to come from low-income families where financial aid is a necessity for completion of a post-secondary degree program. Without scholarships, grants, loans, and/or work study programs, these students are less likely to graduate.
- Curriculum and Instruction Reform: A number of areas in need of reform reported in this article included: curricular and pedagogical reform especially in calculus courses, increasing active learning, the use of group projects, in addition to improving teaching attitudes and behaviors.

Additional studies reported in this article have concluded that integrative approaches are the most successful in maintaining under-represented populations in collegiate STEM programs (9).

Meanwhile, the National Math and Science Initiative (NMSI) published an article in 2013 that focused on strategies for increasing the numbers of underrepresented students in STEM programs. Originally established in 2007, the primary goal of the NMSI was to concentrate on "the declining number of students who are prepared to take rigorous college courses in math and science and be equipped for careers in the knowledge-based economy." In order to achieve this goal, the NMSI proposed the following actions: improve critical thinking skills by increasing student engagement, increase student motivation with positive role models, classroom experiences as well as parental and community involvement, and finally an increased exposure to STEM related courses (10).

In a short report, Celeste Baine outlined a number of measures necessary that should be taken as early as elementary school in order to increase interest in STEM careers among female students and underrepresented minorities. Those recommendations which are relevant to this curriculum unit include the use of: hands on activities, teamwork, collaboration, and pedagogical strategies for improving problem-solving and spatial recognition skills (11).

Classroom Use of Robotics

In 2012, Benitti reviewed ten studies in which the classroom use of robotics was examined (12). Among his conclusions he states the following: "This study has shown that educational robotics have an enormous potential as a learning tool, including supporting the teaching of subjects that are not closely related to the Robotics field." In an earlier study, researchers specifically examined the attitudes of seventh grade female students who participated in the KISS Institute for Practical Robotics' Botball Program (13). It was conducted by three researchers at Southern Illinois University and involved 324 students of which 225 were female students and the remaining 99 being male students. Additionally, the study was based on twelve all-girl robotics teams and twenty-four mixed gender teams. The study was comprised of both a quantitative and a qualitative study. The authors of the study went on to conclude: “The results of this study provide evidence that participation in Botball may help to reduce the gender gap in science and engineering through reducing beliefs in traditional gender roles and increasing positive attitudes about engineering and science and careers in these areas. Given that the Botball program lasts only seven weeks, these results indicate that short-term, well-structured programs that can effectively modify social and cultural beliefs may be particularly promising in encouraging girls to pursue STEM areas for study and careers.”

Strategies

In an ongoing effort to improve student literacy, the School District of Philadelphia adopted an initiative based on six instructional strategies (14). Among the strategies that will be used throughout this unit are: previewing content specific vocabulary, summarizing material by structured note taking, reciprocal teaching, and writing short compositions on what has been read.

Parts of the unit will also necessitate the use of cooperative learning strategies. Classroom management, however, is essential for a successful cooperative learning environment. This can be accomplished through: cooperative management, the will to cooperate, and the skill to cooperate. It is imperative that students understand the guidelines for acceptable classroom behavior. The will to cooperate is developed over time and is based on positive social interactions and pride within the group. The skill to cooperate is based on the ability of the students to assume specific roles within the group, listen to, and work with each other.

The fundamental behavioral skills that are associated with cooperative learning include: simultaneous interaction, positive interdependence, and individual accountability. Within a cooperative learning environment, the students are encouraged to interact with members within their group. This freedom is usually not permissible within a traditional classroom setting. Positive interdependence is gained from the achievement of individual students within the group and from the entire group as a whole. Individual accountability can be addressed by employing a variety of assessments.

Classroom management is always a major concern especially with freshman students. To a large degree, effective classroom management depends upon the structure of the lesson and its delivery. Not only does it involve the arrangement of the students within the group, but it is also dependent upon the manner in which individual lessons are designed and presented. These structures, designs, or activities are meant to improve such areas as team building, information sharing, thinking skills, communication skills, and content literacy. A brief list of classroom structures and lesson designs include: brainstorming, jigsaw, numbered heads together, rally table, round robin, roundtable, student teams achievement division (STAD), team projects, and think pair share. A detailed review of each can be found in *Cooperative Learning* (15).

By improving their note taking skills, students should be able to utilize, practice and/or engage in summarizing content specific material. To achieve that objective, the highly successful technique of note taking that was developed by Walter Pauk will be employed. The Cornell Method, as it is referred to, involves writing a key word, phrase, or concept on the left hand side of a sheet of paper. On the right hand side of the paper, relevant material is then written in short sentences or phrases. Finally, at the bottom of the page, the material listed is then summarized into a short paragraph. This widely used method enables students to improve their skills in summarizing material presented in both lecture and written form (16).

In order to address and improve reading comprehension skills, students will participate in reciprocal teaching techniques. This is another cooperative learning strategy which is designed to encompass the following four skills: summarizing, questioning, clarifying, and predicting. Each student within the group will be responsible for reading a specific section within their textbook and/or assigned reading material, summarizing that material, and reporting out to the rest of the group. This pedagogical strategy has been reported to be successful in both small groups as well as in large classroom settings (17).

Since the strategies used in this curriculum unit will focus on inquiry-based and/or computer based learning scenarios, it is essential that the students be able to work collaboratively in small groups. Therefore, this portion of the unit will be devoted to researching the literature for pedagogical techniques involving a variety of different collaborative learning methodologies and the classroom use of engineering specific computer software programs.

Classroom Activities

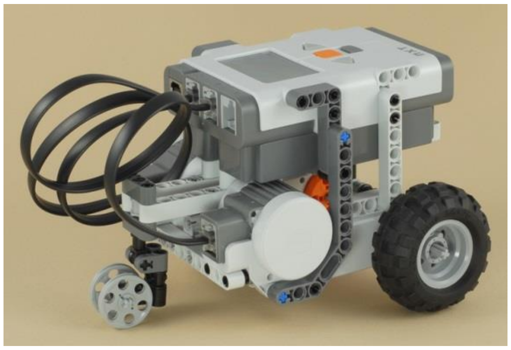
The activities used in this curriculum unit will incorporate the use of Tinkercad, LEGO MINDSTORMS software programs in addition to LEGO Mindstorm kits. These activities involve having sufficient LEGO Mindstorm kits for a class of thirty-two students. Each group is composed of four students. Each activity has been carefully chosen to achieve the primary goal of increasing awareness in STEM careers while increasing their difficulty.

Activity 1:

This activity is designed to introduce students into the use of computer assisted design (CAD) software programs. After watching the short Tinkercad tutorial video at https://www.tinkercad.com, the students will use the CAD program in designing a vehicle that will be able to move and perform a specific function. They will be working in the computer lab in groups of two. This particular activity will take at least three days. Upon completion on their vehicle, the students will print out and submit their design.

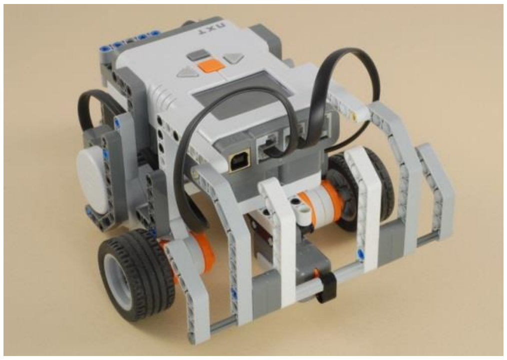
Activity 2:

In this activity, each group of four students will build an NXT Castor Bot which contains a two wheel, two-motor drive with an extra castor wheel in front. This robot will serve as the primary drive unit for the next two activities. The building directions can be obtained from http://www.nxtprograms.com/castor_bot/index.html. Although the Castor Bot is characterized as involving advanced building techniques, NXT programming is not required. The completed robot is pictured below.



Activity 3:

The Castor Bot built in activity 2 will be modified to make the NXT Bumper Car. As the name implies, this robot contains a bumper in front of the robot along with a touch sensor. Once the robot hits an obstacle it will turn and continue moving. Directions for building the Bumper Car can be obtained from http://www.nxtprograms.com/NXT2/bumper_car/index.html. Like the Castor Bot, the Bumper Car requires advanced building techniques. The Bumper Car, however, will involve some basic NXT programming. The program can be obtained with the aid of LEGO Mindstorms NXT 2.0 software and the above website. The completed robot is shown below.



Activity 4:

The final activity in this curriculum unit modifies the Bumper Car by adding an ultrasonic sensor which will aid in detecting obstacles in its path. Directions for construction of the NXT Explorer can be obtained at http://www.nxtprograms.com/NXT2/explorer/index.html. Again the building instructions are considered advanced, but in this case the NXT programming is regarded to be at the intermediate level. The program can be obtained with the aid of LEGO Mindstorms NXT 2.0 software and the above website. The completed Explorer robot is shown below.

Annotated Bibliography/Works Cited

1. United States National Commission on Excellence in Education. *A Nation at Risk: The Imperative for Educational Reform*. Web. 26 Mar. 2013. <http://www.scribd.com/doc/49151492/A-Nation-at-Risk>.

This report focused attention on the problems facing the educational system in the United States.

2. Graham, Edward. "A Nation at Risk" Turns 30: Where Did It Take Us?." *NEA Today RSS*. N.p., n.d. Web. 27 Apr. 2014. <http://www.neatoday.org/2013/04/25/a-nation-at-risk-turns-30-where-did-it-take-us/>.

The author questions the impact "A Nation at Risk" has had on education since its publication thirty years ago.

3. "Academic Standards for Reading in Science and Technology." Retrieved April, 2013 from http://www.pdesas.org/Standard/PAcore

The Pennsylvania common core standards for reading in science and technology are listed for grades six to twelve.

4. "The Next Generation Science Standards | Next Generation Science Standards." *The Next Generation Science Standards | Next Generation Science Standards*. N.p., n.d. Web. 27 Apr. 2014. <http://www.nextgenscience.org/next-generation-science-standards>.

The next generation science standards (NGSS) are discussed in detail.

5. "Key findings - OECD." *Key findings - OECD*. N.p., n.d. Web. 9 May 2014. <http://www.oecd.org/pisa/keyfindings/pisa-2012-results.htm>.

This report outlines the results for students from the United States who participated in the 2012 PISA examination.

6. "Challenges Persist For Minorities And Women." *Electronic Design*. N.p., n.d. Web. 22 Mar. 2014. <http://electronicdesign.com/archive/challenges-persist-minorities-and-women>.

This paper presents findings from a 2005 report from the Commission on Professionals in Science and Technology regarding the employment of minorities in STEM occupations from 1994 to 2004.

7. Tyson, Will, Reginald Lee, Kathryn M. Borman, and Mary Ann Hanson. "Science, Technology, Engineering, and Mathematics (STEM) Pathways: High School Science and Math Coursework and Postsecondary Degree Attainment." *Journal of Education for Students Placed at Risk (JESPAR)* 12.3 (2007): 243-270. Print.

The article discusses the relationship between taking higher level science and math courses and degree attainment in a collegiate STEM program.

8. Darnell Cole, and Araceli Espinoza. "Examining The Academic Success Of Latino Students In Science Technology Engineering And Mathematics (STEM) Majors." *Journal of College Student Development* 49.4 (2008): 285-300.

In this collegiate study of 146 Latino freshman students, the relationship between cultural congruity and academic performance was examined.

9. Tsui, Lisa. "555-581." *Effective Strategies to Increase Diversity in STEM Fields: A Review of Research Literature*. N.p., n.d. Web. 10 Mar. 2014. <http:/www.jstor.org/stable/40037228>.

This article outlines ten strategies that can be used to increase student diversity in STEM fields.

10. "Increasing the Achievement and Presence of Under-Represented Minorities in STEM Fields." *Increasing the Achievement and Presence of Under-Represented Minorities in STEM Fields*. National Math + Science Initiative, n.d. Web. 20 Mar. 2014. <http://www.nms.org/Portals/0/Doc/.../NACME%20white%20paper.pdf>.
This article discusses several underlying problems associated with deficiencies in under-represented minorities in STEM fields and several recommendations to address them.

11. Baine, Celeste. "STEM." *Women and Minorities in STEM Careers Advancing our World*. N.p., n.d. Web. 19 Mar. 2014. <https://www.mheonline.com/glencoemath/pdf/stem_careers.pdf>.
In this paper, Celeste Baine outlines measures needed to improve students' attitudes about careers in science, math and engineering.

12. Benitti, Fabiane. "Exploring the educational potential of robotics in schools: A systematic review." *Computers & Education* 58 (2012): 978-988. Print.
In this review article, the author examines several studies that focus on the use of robotics in the classroom.

13. Weinberg, Jerry, Jonathan Pettibone, Susan Thomas, Mary Stephen, and Cathryne Stein. "The Impact of Robot Projects on Girls'Attitudes Toward Science and Engineering." *The Impact of Robot Projects on Girls'Attitudes Toward Science and Engineering*. N.p., n.d. Web. 22 Mar. 2014. <http://www.roboteducation.org/rss-2007/full>.
This study reviews the positive changes among female seventh grade students towards science and engineering after participating in a robotics program.

14. School District of Philadelphia Office of Curriculum and Instruction. *High School Plan For Content Area Literacy,* 2007, 17-33.
A number of graphic organizers are given along with a brief description of their use.

15. Kagan, Spencer. *Cooperative Learning*. San Juan Capistrano, CA: Kagan Cooperative Learning, 1992, 7:1-8:2, 10:1-10:17.
Spencer Kagan’s book on cooperative learning is an excellent resource for developing and sustaining a cooperative learning environment in the classroom.

16. “Cornell Notes.” *Wikipedia* [Web]. Retrieved March, 2013 from http://en.wikipedia.org/wiki/Cornell_Notes
This article briefly explains the use of the Cornell method in taking notes.

17. North Carolina Regional Educational Laboratory. "Reciprocal Teaching." Retrieved March, 2013 from http://www.ncrel.org/sdrs/areas/issues/students/atrisk/at6lk.38htm
The benefits of reciprocal teaching as well as the steps involved are discussed in this article.

18. "Academic Standards for Reading in Science and Technology." Retrieved April, 2013 from http://www.pdesas.org/Standard/PAcore
The Pennsylvania common core standards for reading in science and technology are listed for grades six to twelve.

19. "The Next Generation Science Standards | Next Generation Science Standards." *The Next Generation Science Standards | Next Generation Science Standards*. N.p., n.d. Web. 27 Apr. 2014. <http://www.nextgenscience.org/next-generation-science-standards>.
The next generation science standards (NGSS) are discussed in detail.

Appendix/Standards

This curriculum unit is aligned with the Pennsylvania Common Core Standards for Reading and Writing in Science and Technical Subjects as well as several performance expectations of the Next Generation Science Standards. The specific standards and performance expectations that will be addressed during the course of this unit were taken directly from: *"Academic Standards for Reading in Science and Technology", "Academic Standards for Writing in Science and Technology"* (18), and "*The Next Generation Science Standards"* (19) and include:

CC.3.511-12.C. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

CC.3.5.11-12.D. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.

CC.3.5.11-12.G. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g. quantitative data, video, multimedia) in order to address a question or solve a problem.

CC.3.6.11-12.E. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

CC.3.6.11-12.F. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

CC.3.6.11-12.G. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source following a standard format for citation.

HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-4: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.