

PROJECT DEMONSTRATING EXCELLENCE

After-school Enrichment and the Activity Theory: How can a management service organization assist schools with reducing the achievement gap among minority and non-minority students in science, technology, engineering, and mathematics (STEM) during the after-school hours?

by

Reagan D. Flowers

Submitted in partial fulfillment of the requirements for the Degree of

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with a concentration in Educational Leadership/Systems
and a specialization in Curriculum and Instruction**

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**Union Institute & University
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The completion of the total Learning Agreement and the Project Demonstrating Excellence (PDE) are judged on evidence of: (1) a thorough proficiency in the field; (2) the use of appropriate research methodologies; (3) originality of approach in the research and application aspects of the PDE; (4) understanding the role that the total learning experience and knowledge gained can play in the solution of practical societal problems; (5) clarity of written and oral presentations; (6) additional insights into the nature of scholarly research and creative activities undertaken during doctoral study provided by the Internship; (7) a clear understanding of the creative art (or arts) where appropriate. These constitute the criteria for granting the Ph.D. degree.

This is to certify that we, the undersigned, have examined all academic aspects of this candidate's program, including those delineated above, and reflected in the PDE, Program Summary, and Transcript Draft documents and hereby recommend to the Dean of the Doctoral Program and to the President of Union Institute & University that the degree of Doctor of Philosophy be awarded.

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This is to certify that I have examined all aspects of this candidate's academic program and the recommendation of the candidate's committee members and hereby recommend to the President of Union Institute & University that the Ph.D. degree be awarded.

Dean: _____ Type/Print Signature/Date: _____

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After-school Enrichment and the Activity Theory: How can a management service organization assist schools with reducing the achievement gap among minority and non-minority students in science, technology, engineering, and mathematics (STEM) during the after-school hours?

(Under the direction of Dr. Leland K. Hall, Sr. and Dr. Lisa Marling)

ABSTRACT

The primary purpose of this study was to investigate how a management service organization can assist schools with reducing the achievement gap between minority and non-minority students in science, technology, engineering, and mathematics (STEM) during the after-school hours. Developing a strategic plan through creating a program that provides support services for the implementation of hands-on activities in STEM for children during the after-school hours was central to this purpose. This Project Demonstrating Excellence (PDE), a social action project, also presents historical and current after-school program developments in the nation. The study is quantitative and qualitative in nature. Surveys were utilized to quantitatively capture the opinions of participants in the social action project on three specific education related issues: (1) disparity in academic motivation of students to participate in after-school STEM enrichment programs; (2) whether teachers and school administrators saw a need for STEM after-school enrichment; and (3) developing STEM after-school programs that were centered on problem-solving and higher-order thinking skills to develop students' interest in STEM careers. The sample consisted of 50 participants comprised of students, teachers, and administrators. The focus groups and interviews provided the qualitative data for the study. The qualitative sample consisted of 14 participants comprised of

students, parents and teachers, administrators, an education consultant, and a corporate sponsor.

The empirical data obtained from the study survey, focus groups, and interviews provided a comprehensive profile on the current views and future expectations of STEM after-school enrichment, student and school needs, and community partnerships with STEM companies. Results of the study and review of the implementation of the social action project, C-STEM (communication, science, technology, engineering, and mathematics) Teacher and Student Support Services, Inc., revealed the need and focus for STEM after-school enrichment programs in Houston, Texas. This result, along with requirements of STEM Research and Special Programs Administrations and a multiyear and multilevel strategic plan inspired by this study, led to the conceptualization, development, and implementation of C-STEM Teacher and Student Support Services, Inc. at multiple schools in Houston, Texas. The purpose of C-STEM Teacher and Student Support Services, Inc. is to provide hands-on support services that encourage schools, organizations and families to improve academic achievement and socio-emotional development through project-based learning in communication, science, technology, engineering, and mathematics (CSTEM) in grades 4-12.

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I. Definitions

The following definitions are specific to this study.

Academic: concerning teaching or learning.

Adjunct faculty: a person in one of the higher professions who is hired to work for an organization such as a university for a short period of time.

After-school enrichment: engaging activities for youth during the after-school hours.

Alliance: a bond or connection between families, states, parties, or individuals, i.e. a closer *alliance* between government and industry.

Bloom’s Taxonomy: higher order thinking.

Cognitive Domain: thinking capacity; ability to comprehend and apply information.

Commonalities: having common features or attributes.

Critical Thinking: problem-solving; Maslow’s Higher Order Thinking Skills.

C-STEM: communication, science, technology, engineering, and mathematics.

Instruction: teaching aids.

Division of Labor: the separation of a work process into a number of tasks, with each task performed by an individual or group of individuals.

Enrichment: to make rich or richer especially by the addition or increase of some desirable quality, attribute, or ingredient; i.e. the experience will *enrich* your life.

Extracurricular: activities outside the regular course of work in school or college.

Hands-on: relating to, being, or providing direct practical experience in the operation or functioning of something.

Independent Thinker: intrinsically motivated; self-supported.

Inner-city: the usually older, poorer, and more densely populated central section of a city.

Latch-key children: left home unsupervised after school while parents are still at work.

Minority: references African-American and Hispanics.

Non-minority: references Whites.

Problem-Solve: use not only trial and error but also insight based on an understanding of principles, inductive and deductive reasoning; and divergent or creative thinking.

Self-confidence: belief in one’s own power to do things successfully.

Social Action Project: analyzed large-scale societies in terms of their social, psychological, and cultural components and focused on problems of social order, integration, and equilibrium.

Socioeconomic: of, relating to, or involving a combination of social and economic factors.

TEKS: Texas Essential Knowledge and Skills.

Tutoring: an individual who gives private instruction to a single pupil or a very small class.

Underrepresented: inadequately represented.

Underserved: provided with inadequate service.

ZPD: Zone of Proximity.

II. Introduction

The Project Demonstrating Excellence (PDE) is an action research methodology. It is in two parts. The first portion is the implementation of a social action project and the second is a contextual essay of findings. The PDE takes the form of a dissertation, which is of mixed methodology design. It is also a historical study with a dominant/less-dominant design. The qualitative design was chosen as the dominant approach in this study and is structured by research questions. It describes and makes interpretations about objects, settings, conditions, and events that pertain to after-school enrichment and the activity theory. The quantitative approach is a small component of the study.

In order for the learner to carry out the social action project, C-STEM (communication, science, technology, engineering, and mathematics) Teacher and Student Support Services was formed as a corporation and recognized by the Internal Revenue Service as a non-profit organization. The learner piloted the social action project, C-STEM, in a public middle school in Houston, Texas. The organization examines factors that influence after-school programs in order to assist schools in reducing achievement gaps between minority and non-minority students in mathematics and science. The social action project allows the learner to establish an inquiry based setting to gather data and information on what children, teachers, and administrators say, think, and feel are the underlying motivations, assumptions, and beliefs on after-school programs and their impact. The learner’s prior experience is the catalyst that cultivated interest in developing a management service organization for science, technology,

engineering, and mathematics (STEM) enrichment to provide services to schools not participating in such activities or those schools wanting to broaden their student population experiences in those areas.

This action research project is the direct result of there being no Houston-based organizations geared toward providing support services for schools with implementing STEM after school, hands-on activities, and enrichment programs. A search for other programs like C-STEM through the Department of Education and Texas Education Agency records revealed no organization with similar mission and goals. There are numerous after-school initiatives funded at the city, state, and federal level but they all appear to be different in focus. This social action project has been supported by numerous funding sources listed below:

1. ASME (American Society of Mechanical Engineers) Petroleum Division Grant, (2002-2005)
2. Alliance Engineering Donation, (2003)
3. The Wood Group Donation, (2003)
4. United Way Grant, (2003)
5. Best Staff Technical Services Donation, (2002-2005)
6. Joseph High Donation and Conoco Matching Funds, (2002-2005)
7. Participating middle school PTO Grant, (2002)
8. C-STEM Annual Golf Tournament, (2002-2004)
9. C-STEM Application Fee, (2002-2004)
10. C-STEM Fundraisers, (2002-2005)
11. Participating Middle School Contract Fee, (2002-2005)
12. Mayor’s After-school Achievement Grant, (2004 & 2005)
13. Shell, (2005)

The financial contributors have funded operational costs including resource materials, copying, office supplies, stipends for staff, field trip expenses, tools, competition entry fees, after-school snacks, an annual banquet, awards, a Website, video

and photography, vehicle rentals and administrative costs.

The learner’s professional experiences in education have led to the belief that minority students are not receiving an education that prepares or motivates them for a career in mathematics or science. During time spent as a classroom teacher, the learner noted that many students did not see the real-life application of math and science. The majority of these students took the minimum requirements in math and science to satisfy minimum graduation requirements. The learner has found that providing students with hands-on learning activities that integrate math and science is the key to engaging students and making them eager to do more and learn more about these subjects.

During my time as a classroom teacher in 2000, a grant opportunity through NASA was presented to the school. After several years of working with children in an after-school science club, this learner began to see the need for, and the impact, STEM enrichment activities had in the lives of minority children. This motivated the learner to write the NASA grant, attend more STEM enrichment competitions and learn more about STEM enrichment opportunities for children. With the learner’s increased attendance at more STEM events, it was observed that there were very few minority students participating. It was at that time that the learner decided to create an organization that would assist schools with getting and remaining involved in STEM activities over time. The thought was that C-STEM would provide opportunities to schools to create greater interest and passion in children for STEM, nurture those that had an innate interest in STEM, provide teachers with hands-on activities that could be taught in the classroom, and increase the number of minority students that were successful with completing post-

secondary studies in related fields. The rationale for observing and dialoguing with the student group participating in the C-STEM after-school program was to bring meaning that would reveal thoughts and allow for a transformation in the instructional delivery of STEM after-school programs that support instruction occurring during the school day.

In this research study, minority and non-minority student groups were selected. According to Thompson (2005), 2.4 percent of Hispanics and 2.7 percent of African Americans represent the number of science and engineering degrees in the United States. These groups represent the largest academic achievement gap in math and science. Five years of experience as a science educator in an inner-city public school led to the discovery of numerous STEM enrichment programs, and if properly implemented and maintained, such programs can reduce the achievement gap in mathematics and science. However, two factors contribute to the lack of minority student participation in STEM enrichment programs. The first factor is that all STEM enrichment programs have a financial cost (i.e. entry fees, materials/supplies, transportation, no substantial monetary compensation for teachers etc.) associated with them. Most economically disadvantaged high minority schools typically do not have funding, staff, parental involvement or resources to support STEM after-school enrichment programs. There is often no funding available in the school budget to purchase materials for projects or to compensate a teacher’s time. Teachers are forced to locate funding to support these programs and projects from outside sources, and in most instances whatever funding is located goes directly to the activity’s expenses.

A second factor contributing to the lack of minority student participation is that

all STEM enrichment programs require a time commitment from teachers. These same teachers generally lack adequate professional development training and the resources necessary to implement STEM enrichment at their schools. STEM enrichment activities are not written into most schools curriculum: if a teacher has an interest in doing a project with a group of students, the teacher is typically required to remain after-school to meet with those students. Due to the amount of effort it takes from the teacher to successfully implement a STEM idea, the learner has observed that a large percentage of teachers end up burned out after their second year and disassociate themselves from the project/program.

C-STEM operates on school campuses, providing a safe environment for students to work and learn after-school. According to Wilgoren (2000), “78 percent of mothers of school-age children are in the work force and with welfare reform pushing more into jobs; millions of children are on their own between 3 p.m. and 6 p.m.” These hours are when children are most likely to commit crimes or be victimized. Additionally, there is public frustration with school failures and poor performance by students on standardized tests (Wilgoren, 2000). C-STEM is monitored by the Texas Department of Family and Protective Services and is permitted to operate as a licensed childcare center on a public school campus during after-school hours. The student participants in the program receive healthy snacks, mentors, guidance counseling services, and work alongside industry professionals to complete challenging STEM projects. Students also develop socially through academic competitions, field trips and interaction with their peers, parents, and volunteers. C-STEM also serves as a resource for communicating to parents the types of

services that are available in the community, and as a liaison for working parents. This allows the parents to track the academic success of their child/children and developments at school.

Student participants do not have to travel from home to participate in C-STEM because it is implemented on the schools campus as an after-school program. At the conclusion of the after-school program each day, students travel home safely using whatever means of transportation arranged by their parent or guardian.

Any child that has an interest in participating in STEM enrichment projects is allowed the opportunity to participate in the C-STEM after-school program. Since C-STEM Teacher and Student Support Services is a non-profit organization, all activities are funded through grants, fundraisers, and donations. The STEM activities that are implemented were selected to assist schools with meeting the needs of the student group targeted for this study: they were carried out in active collaboration with the school, the students and C-STEM Teacher and Student Support Services.

STEM activities are intense and competitive while teaming professionals, teachers, senior volunteers, parents and students to solve problems. During each after-school session, the students focus on a STEM project activity. For this study, three STEM project activities were selected: Space City BEST Robotics, FIRST Robotics, and SECME, Inc. The activities named are all competition based and require the students to create a working model constructed by hand from a select list of materials and resources. Student participants were required to commit to the C-STEM program for a year in order to complete all three projects. Each STEM activity is described below:

1. For Inspiration and Recognition in Science and Technology (FIRST) Robotics Competition - the goal of this event is to ensure that students of all ages have the opportunity to discover the excitement and rewards of science, math and technology by challenging them to build a remotely controlled robot to accomplish a task within a specified time frame given certain parameters.
2. SECME, Inc. Competitions - a strategic alliance to renew and strengthen the professional capacity of K-12 educators, motivate and mentor students, and empower parents so that all students can learn and achieve at higher levels. The competition requires students to build mousetrap cars, write essays, and design posters around a given theme.
3. Boosting Engineering Science and Technology (BEST) Robotics Competition - inspires and motivates students by challenging them to build a remotely controlled robot to accomplish a defined task within a competitive setting. Professional engineers, industry consultants and teachers are used as coaches to guide student teams through the engineering process.

The activities meet the principles of effectiveness by increasing student achievement in core academic areas and on standardized tests. The STEM competitions are high-tech spectator sporting events which are the result of focused brainstorming, multi-leveled collaboration, real-world teamwork, dedicated mentoring, project timelines, and deadlines. A goal in implementing C-STEM is to ensure that children of all ages have the opportunity to discover the excitement and rewards of science, engineering, math and technology.

The C-STEM after-school program implements hands-on, competition-based STEM enrichment activities for children in grades 6-8. The program operates from 3:50 p.m. to 6:00 p.m., Monday through Friday on the participating middle school campus. The group averages approximately 25 students daily throughout the year and is comprised of both boys and girls. As of this writing, the group had met five days a week

during the academic calendar year, and on some Saturdays, for approximately 2 years and 8 months.

Participants in the C-STEM after-school program are provided a work space to build their models. In this instance, the work space was created in a small room attached to a computer technology classroom and used as a wood and metal shop. The students worked on their projects in groups of 4-5. The problem that the students have to solve varies according to the project. The FIRST project required the students to design and build a robot within specified weight, height, length, and width constraints that could pick-up several balls, place them inside of a seven foot goal, and pull the goal from one end of the playing field to a scoring zone within two minutes. The BEST project required the students to design and build a robot that could grab balloons that were representative of red and white blood cells and move them to containers that were representative of cell savers within a two minute time frame. The SECME competition consisted of three components. The first component required students to design and build a car out of a mousetrap that could travel a great distance within certain specified measurements and weight. The second component required students to design a poster according to a theme and the final component was to write an essay on that same theme.

Each student group typically works on a different aspect of the same STEM project and attaches their respective component to the project model at its completion. Students that participate in the program are trained on safety in the shop area and learn how to operate the tools properly. Working along side the learner, with the students, each day is a program advisor (PA) and a teacher volunteer. The PA is responsible for many tasks:

making certain that the students signed in/out, returning forms, contacting the parents, distributing snacks, organizing materials, supervising the students, chaperoning students on outings, assigning volunteer duties, and keeping inventory. These duties were created to ensure proper supervision, safety, and to maintain students’ focus. The students were allowed to use the following tools to create their prototypes and working models:

1. Welder
2. Grinder
3. Band Saw
4. Jig Saw
5. Hand Drill
6. Drill Press
7. Soldering Gun
8. Table Saw
9. Hand Tools

The student participants were introduced to a wide range of working materials for their projects. They were allowed to use these tools in creating their prototypes and working models as a solution to their STEM activity problem. The following list outlines the type of materials the students were allowed to use to create their project solutions:

1. Steel
2. Aluminum
3. Plexy Glass
4. Angle Iron
5. PVC
6. Wood
7. Nuts, bolts, screws, nails, washers, etc.
8. Springs/Hinges
9. Electrical wiring & connectors
10. Computer memory boards
11. Motors (i.e. drill, window, etc.)
12. Relays
13. Fuses
14. Wireless Remote Controls
15. Pneumatics/Hydraulics

16. Wheel Chassis

17. Bicycle Chains & Spokes

To start the year, student participants were first given an orientation on C-STEM. The students were excited to have an opportunity to work with all of the tools and build robots that would cost in excess of \$7,000.00. C-STEM staff then explained shop rules, the project timeline, project rules and constraints. Finally, students were grouped according to their area of interest (i.e. mechanical, electrical, computer programming, and design, etc.).

A short time after introducing the student participants to tools, an observation was made that supported the research of McLoughlin (1999). Tools mediate forms of interaction with the environment and support problem-solving. C-STEM requires the use of hand tools for the construction of STEM projects. . The learner observed that through tool usage, the students achieve success with their hands-on projects and develop an understanding about the world around them. It was Vygotsky (1978) who stated that one of the most convincing cognitive approaches to learning can be manifested through the Activity Theory. According to the Activity Theory, the basic unit of analysis is an activity that can be described in terms of a subject (an individual/group) and an object (an objective/purpose). Tools, both physical and psychological, mediate between subject and object. Kuutti (1995) has described activities in terms of a three level hierarchy:

1. Activity – corresponding to a motive.
2. Action – corresponding to a goal.
3. Operation – corresponding to a condition such as an automatic or unconscious act.

Cole and Engestrom (1993) have extended the Activity Theory structure to include rules,

community and division of labor. Vygotsky (1978) further delineated the Activity Theory by proposing the concept of a zone of proximal development (ZPD). Vygotsky has defined the ZPD as the distance between an individual’s current development and her/his potential if provided with an opportunity to learn. The C-STEM program followed the Activity Theory in its implementation. The Space City BEST, FIRST Robotics, and SECME competitions each have a corresponding motive: to teach the students math and science via a creative problem-solving activity that allows non-traditional methods of thinking and routes to content mastery. Each activity also had a corresponding goal, which was to provide children with an outlet to learn and explore math and science with a fun and exciting methodology that is applicable in the real world. The student participants must take action in order to accomplish their goal as a team, and each participant must take ownership of particular jobs. The goal of the student participants is to complete the project to specifications within the timeline provided and to successfully demonstrate that their model can complete the tasks it was designed to do. The students operate with a level of commitment and routine that is not spoken, but demonstrated as they journey through each activity from start to finish.

III. Literature Review

The Need for After-School Programs

There are more than 28 million school-age children who have parents working outside of the home, yet only six million children grades K-8 participate in after-school programs. Approximately 22 million do not have access to quality, affordable care during the after-school hours. Additionally, the number of working parents of school-age

children continues to increase. Pola (2004) indicated in a study that in 69% of all married-couple families with children between ages 6-17, both parents work outside the home. In single parent households with children ages 6-17, 71% of children from single mother families and 85% of single father families have working parents. It is estimated that this leads to a gap between parent/work schedules.. Approximately 20 to 25 hours per week, children are without adult supervision. This schedule gap has led to a growing demand for quality after-school enrichment programs (Pola, 2004).

According to the United States Department of Education (1999), school-age children who are unsupervised during the after-school hours are more likely to use alcohol, drugs, and tobacco; engage in criminal and other high-risk behaviors; perform poorly in school; display increased behavior problems; and drop out of school more often than those children who have the opportunity to benefit from constructive activities supervised by responsible adults.

Despite the obvious need, there is an unremitting scarcity of after-school programs available to serve children. The demand for school-based after-school programs outstrips supply at a rate of about two to one. Additionally, it is even more challenging to find quality after-school programs to meet children's needs beyond elementary school. Childcare for middle school students is often not available because of their age. The early stages of adolescence begin during the transition to middle school. At this stage of their development, children find more success with their independence when they receive attention, support, and supervision from caring adults (Pola, 2004).

The United States Department of Education (1999) has reported that quality after-

school programs help children develop better social skills. After-school programs also teach children how to handle conflicts in more socially acceptable ways. The emphasis that is placed on reading and math improvement in such programs lends itself to improved academic success in students which in turn, leads to increased self-esteem. According to Pola (1999), the goal of after-school enrichment programs should be to assist students with developing the intrinsic motivation necessary to complete assignments independently and to become life-long learners.

After-School Programs Sociological Influences

Gordon (1999) recognized that schools require health, human, policy, cultural, and social capital to make student achievement possible. The aforesaid is what occurs in schools and the unequal distribution of these capitals relentlessly restricts the effectiveness of schools. The redistribution of access to such capitals is often beyond the immediate reach of students. Schools that utilize supplemental education (i.e. after-school programs) can find support for academic learning. Opportunities to participate in such activities for low-income (i.e. the poor) and some ethnic minority (i.e. African American, Hispanic, and Native American) student groups are generally underutilized in comparison to patterns associated with White and Asian Americans from mid to high socioeconomic backgrounds (Gordon, 1999).

Schools alone cannot ensure high academic achievement. Parents have to make available to their children supplemental education experiences (Coleman et al., 1966). It was Comer (1997) that asserted this position more forcefully in *Waiting for a Miracle: Why Our Schools Cannot Solve Our Problems and How We Can*. Well informed parents

are aware that there are a number of things that occur outside of school that appear to enable schooling to work. Coleman (1966) concluded that the differences in the family backgrounds of students, as opposed to school characteristics, accounted for the greatest amount of variance in an individual’s academic achievement. Gordan (1999) later found that Coleman’s (1966) findings were less valid for low-income and ethnic minority children than for the general public. It is the presence of familial support for academic development that may explain the association between family status and student achievement (Mercer, 1973 & Wolf, 1966).

Academically successful populations are primarily comprised of White and Asian Americans with mid to high socioeconomic status and it is reasonable to assume that such individuals tend to have a strong combination of home and school resources to support their academic development (Birch & Gussow, 1970; Gordon & Meroe, 1989; the National Task Force on Minority High Achievement, 1999). Conversely, parents and educators need to create high performance learning communities for those students who are not naturally exposed to academically demanding environments where serious academic work is respected, standards are explicit, and high achievement is rewarded (Gordan, 1999). For students with a lower socioeconomic status, and/or students of color, negative school experiences can result in failure to develop positive self-concepts and the outright rejection of aspirations for academic achievement. These results may be improved with supplementary education interventions that allow students to grasp the relevance of education. Supplemental education occurs outside of school and beyond the regular school day or year offering formal and informal learning and developmental

enrichment opportunities. Gordan’s (1999) idea of supplemental education is based on the premise that beyond exposure to the school’s formal academic curriculum, high academic achievement is closely associated with exposure to family and community-based activities, and learning experiences in support of academic development that occurs outside of the school.

After-School Programs Impact on Child Development

The implementation of many after-school programs serves as a prevention mechanism to counter negative peer influences (Brown, 1990; Ruben et al., 1998). All students, regardless of economic and social background require substantial amounts of help, instruction, discipline, support and caring as they develop from childhood to adolescence and adulthood. During adolescence, individuals become much more interested in understanding others’ internal psychological characteristics, and friendships come to be based more on perceived similarity in these characteristics (Selman, 1980). Many adolescents attach great importance to peer activities—substantially more importance than they attach to academic activities (Wigfield et al., 1991). Often to the dismay of parents and teachers, activities with peers, peer acceptance, and appearance take precedence over school activities, particularly during early adolescence. It is further indicated by Wigfield (1991) that adolescents’ confidence in their physical appearance and social acceptance is often a more important predictor of self-esteem than confidence in their cognitive or academic competence. Peer interaction is also particularly important for the kinds of advances in cognitive reasoning associated with adolescence, precisely because these interactions are more democratic than adult-child interactions (Vygotsky,

1978). In part, this is because of the importance of social acceptance, children’s conformity to their peers and susceptibility to negative peer influence peaks during early adolescence (Brown, 1990; Ruben et al., 1998). There have been numerous articles about how peer conformity can create problems for adolescents, and about how “good” children often are corrupted by the negative influences of peers, particularly by adolescent gangs (Harris, 1995; Steinberg, 1997; Steinberg & Morris, 2001).

Diversity as it relates to the demographic and cultural make-up of student groups allows individuals to acquire attitudes, competencies and values, and make social connections that will help in the successful transition from adolescence to adulthood. After-school programs must take into consideration their structure to ensure that student participants do not experience racism, prejudice, or cultural intolerance so that all students feel a sense of belonging (Arnett, 1999).

Cognitive theorists such as Zimmerman (1989) and Siegler (1986) have assessed how more specific information-processing skills (topic-specific thinking and problem-solving skills), cognitive learning strategies (strategies consciously used by people to learn new information), and metacognitive skills (skills related to the conscious monitoring of one’s own learning and problem-solving activities) change over development. There is a steady increase in the information-processing skills and learning strategies of children, their knowledge of a variety of different topics and subject areas, their ability to apply this knowledge to new learning situations, and their awareness of personal strengths and weaknesses as learners. It is evident that development occurs over time and the environment cultivated through after-school programs should provide

students with positive experiences in a setting with abundant opportunities to refine their life skills. This lends itself to students moving into productive jobs and other roles that build fulfilling relationships.

After-School Programs Link to Educational Reform

According to Noam (2003), 94% of U.S. voters surveyed indicated in 2001 that they saw the need for children and teens to participate in organized learning activities each day after-school. The federal government responded to this growing need in 2002, by increasing funding to the tune of \$1 billion dollars for the 21st Century Community Learning Centers. This provided an opportunity for more schools who qualify to implement quality after-school programs. The effort of the federal government, infusing dollars and combining creative individuals, is helping after-school education to become a large proponent of education reform and community development (Noam, 2003).

The National Association of Elementary School Principals released a survey in 2001 that showed 67% of principals offered optional after-school programs at their school. The percentage of principals offering after-school programs is good, but very few have been trained on how to best organize after-school time on their school’s campus or in their districts. In addition, there are not many colleges or universities training future educators in after-school programming and community initiatives. According to Noam (2003), the most interesting efforts occur in the after-school movement when schools, community-based organizations, museums, universities, or clinics join forces to create a system of after-school care and education. The city of Boston is a good example of the after-school movement. In Boston, communities and institutions have linked to support

educational inventiveness. The Harvard After-school Initiative (HASI) is a part of a partnership, along with 13 other organizations, working to expand the amount and quality of after-school programming in Boston. There are other cities following suit with after-school initiatives. San Francisco has the Beacon Initiative and Los Angeles has L.A.’s BEST (Noam, 2003).

The link between school and after-school programming is to create learning opportunities. All after-school programs do not have to be school-based or be school-like. Children should experience an integration of different learning goals in order to deepen their exploration and skill set. The learning in after-school programs should occur through diverse learning environments. There has been an increase in the number of programs that divide the time into non-academic learning and recreational activities and programs structured around academic activities (Noam, 2003).

After-School Programs and Project Based Learning

After-school programs that offer project-based learning experiences can assist children in a variety of ways. Project-based learning activities place students in a position where they have to conceptualize goals and objectives, develop plans and make adjustments, work democratically as a team to make a product, and seek out new learning experiences. Some other positive outcomes include: increased self-confidence, improved communication skills, and acceptance of individual differences. The ultimate benefit is that the children reach their goals and receive support from caring adults through a learning activity that is created (Noam, 2003).

In after-school programs, such as those supported by organizations similar to that

of The After School Corporation and Harvard’s Graduate School of Education’s Project Zero, project-based learning is taking place. Project-based instruction fosters engagement, dedication, community, and skill building. This type of instruction requires a great deal of time and is a more complex form of teaching. To implement quality, project-based learning activities in after-school programs, there needs to be a great deal of staff training (i.e. robotics curriculum) and support services (i.e. teacher assistants, ordering supplies, volunteers, and locating funding sources, etc.). Oftentimes, school teachers avoid project-based learning because of the organization and coordination skills required in putting together materials and grouping students. According to Noam (2003), some of the best pedagogy in after-school settings usually occurs with staff insufficiently trained. The after school setting provides opportunities for projects, community, service-learning, exploration, discovery, and fun, and allows children to develop their own voice in an environment that feels different from school. The project-based learning concept in after-school programs is astounding, but many programs do not have the ability to embark on this multifaceted pedagogy (Noam, 2003).

After-School Programs and Problem Based Learning

Problem-based learning engages students as they pursue specific learning outcomes that are in line with academic standards or course objectives while using real-life problems (Stephien & Pyke 1997). In a problem-based learning environment the students’ work through the problem as a stakeholder and the teacher acts as a guide or advisor. Students explore the issues involved, formulate probing questions, conduct research, and consider possible solutions to the problems (Guhlin, 2003). According to

Stepien and Pyke (1997), a problem-based learning situation must meet several criteria. The problem must engage students through experiences that scaffold higher order thinking to accomplish curriculum objectives, and must include age appropriate topics.

After-School Programs Impact on Low-income and Minority Students

The Education Trust (2004) stated that education finance data masks serious inequities by strictly looking at averages. States like New York and Pennsylvania are standouts. Their reports reveal that they spend far less money on the education of poor minority children than they do on other children. Schools that have high populations of economically disadvantaged students receive fewer dollars from the state to support instructional programs. New York and Pennsylvania fund instructional programs but the spending is not distributed equitably (The Education Trust, 2004).

In a report completed by The Education Trust (2004), the depth of the fiscal inequalities for both low-income and minority students was revealed. The following was shown:

1. In most states, districts with a high number of low-income students receive substantially fewer state and local dollars per pupil than districts with few such students.
2. While the funding gap between high and low poverty districts was narrowed somewhat over the past several years it has increased significantly in seven states; Alabama, Arizona, Louisiana, Michigan, Pennsylvania, Texas, and Virginia.
3. In most states, districts with large numbers of minority students also receive substantially fewer state and local dollars per pupil than do their counterparts with few minority students.

Due to these disparities, Congress was prompted to pass the No Child Left Behind Act (NCLB) in an effort to close gaps between high- and low- performing children, especially

the achievement gaps between minority and non-minority students, and between disadvantaged and advantaged children (Department of Education, 2005). The NCLB holds educators accountable for improving the performance of every group of students. However, according to The Education Trust (2004) analysis, school districts that educate the greatest number of poor and minority students have less state and local money to spend per student than districts with the fewest poor and minority students. Knowing this information, greater efforts by school districts to help their students reach state standards inevitably occur (The Education Trust, 2004). There are those who argue that the effects of poverty and family background overwhelm anything that schools can do, and that the fiscal inequities do not matter. Research has shown that all children can achieve at high levels when the right combination of tools and strategies are employed. The right tools and strategies include: high expectations and clear standards that are applied to all students, rigorous curricula, well prepared teachers supported with high quality professional development, additional instructional time for students who aren't meeting standards, and more focused resources (The Education Trust, 2004).

After-School Programs Bridge to the Community

Partnerships between after-school programs and community entities enhance learning opportunities for children and youth by connecting student participants and community partners (Connell & Walker, 1995). There are numerous grants that support after-school programs; the grant initiatives allow individuals to solicit and galvanize partnerships with a wide range of local organizations and agencies. Museums, art galleries, dance troupes, local symphonies and music ensembles, multicultural

organizations, and local, state, and national parks are all prime candidates for grant assistance. Participation with community partners can and does take many forms, such as a six-week ethnic dance class, a once-weekly visit to a library, attending a performance of a local children's theater, visiting an eco-station or taking a docent-led tour of an art museum. Community partnerships also provide grant funds to assist community organizations or agencies in partnering with after-school programs. Funds are used for expenses that might otherwise present a barrier to student participation, such as transportation costs, and supplies and materials. Funds are awarded to programs based on an application process and criteria established by project stakeholders (Hollister & Hill, 1995).

In the state of California, the Community Connections Initiative is expected to assist with the establishment of 200 new after-school programs in the four regions of the state in which it operates. Regional infrastructures are being developed and strengthened, with the intent of continued support to other programs and community connections in the future. Those involved in the partnership's hope is that the Community Connections Initiative will establish a model approach that can be replicated in other areas of the state (Hollister & Hill, 1995).

After-School Programs connection with Federal and State Law

The findings of a four-part study examining the landmark No Child Left Behind (NCLB) Act through its first year of implementation (2002-2003) was released by the Civil Rights Project at Harvard University (CRP). The research represents each level of government—federal, state, and district—and focuses on state-federal relationships and

the effects of school choice and supplemental education services on school districts. The reports take a unique approach and examine, at every level, the status of NCLB, as well as the intended and unintended consequences of the law, how the various levels of government work together to implement it, and how it works for low-income and minority students.

The study illustrates educators at all levels struggling to implement a dramatic and extremely complex change in federal education policy, which radically alters the role of federal and state governments while imposing unprecedented responsibilities and accountability for test score gains. The report demonstrates that federal accountability rules have derailed state reforms and assessment strategies, which the new requirements have no common meaning from state to state, and that sanctions fall especially hard on minority and integrated schools, as much less progress is required from affluent suburban schools. The market- and choice-oriented policies, which were imposed on schools "in need of improvement," have consumed resources and local administrative time but have small impacts and are not being seriously evaluated (Civil Rights Project, 2004).

The NCLB Act supports after-school programs with federal funding through the 21st Century Community Learning Centers (21st CCLC) initiative. According to the After-school Alliance (2004), NCLB promised \$2 billion in federal funding for 21st Century Community Learning Centers in the fiscal year 2005. The president's promise has fallen short by \$1 billion. The 21st CCLC is an after-school initiative that was initially funded in 1999. This program provides expanded learning and enrichment opportunities outside the regular school hours for children and adults in elementary and

junior schools. The initiative is one of the most efficient, effective providers of quality after-school programs and serves as a national model. The 21st CCLC spans all 50 states, serves 1.2 million children, is designed to reflect the needs of the local community, and requires less than half the administrative expenditures allowed by the law (After-school Alliance, 2004). As it relates to STEM education the 21st CCLC are not required to incorporate STEM project-based learning activities but are required to offer high-quality services in at least one core academic area, such as reading and literacy, mathematics, and science. However, with the budget falling short, there are still millions of children and parents having to find another way to manage work, school, learning, and safety.

After-school care has a growing recognition among policy makers, community stakeholders, families and schools that after-school time serves far more than a childcare function. This is exemplified by the ever-broadening stakeholder support for after-school programs, and the significant increase in funding for comprehensive after-school programs (After-school Alliance, 2004).

With the implementation of the NCLB Act, one of the greatest changes in the after-school field is the need to create innovative organizational and governance structures to facilitate connections with schools, families, and communities (After-school Alliance, 2004). After-school programs are typically collaborative spaces. After-school programs represent a unique social space that does not belong to any one group or organization. The array of collaborations that constitute after-school arrangements require new forms of coordination, flexible methods of management, and innovative research strategies (Noam, 2003).

Job Opportunities for Minorities in Math and Science

According to the Scientists and Engineers Statistical Data System (SESTAT) and the book *Women, Minorities, and Persons with Disabilities in Science and Engineering* (2000), about 27 % of employed white scientists and engineers are younger than age 35, compared with the between 35% and 38% of Asian, Black, American Indian, and Hispanic scientists and engineers. The educational attainment of scientists and engineers differ among racial/ethnic groups. According to the book, Black scientists and engineers have, on average, a lower level of educational attainment than any of the other racial/ethnic groups. Another important issue is the differential of annual salaries between men and women, as it relates to differences in ethnicity, age, occupation and level of education.

Salaries for scientists and engineers differ among all groups. For example, the median salaries of full-time scientists and engineers in 1997 were \$55,000 for whites, \$55,000 for Asians, \$50,000 for Hispanics, \$48,000 for Blacks and \$46,000 for American Indians. Another statistic to examine is the difference between median annual salaries of female scientists and engineers of various ethnic groups and those of male scientists and engineers. This salary trend also held true across most broad occupations and age groups. As with engineers, SESTAT showed that when comparing female computer and mathematical scientists in the 20 to 29-year-old age group, the median salaries for women were \$46,000 for Asians, \$40,000 for Whites, \$38,000 for Hispanics, and \$35,000 for Blacks. Median salaries were \$49,000 for Asians, \$44,500 for Whites, \$41,000 for Hispanics and \$38,000 for Blacks, respectively. In short, male minorities, on

average, make less than their White peers, while female minorities make even less than their male White and minority counterparts.

Summary

The forces behind increased funding and activity in after-school programming can be characterized in two phrases: *time on task* and *home alone*. These two phrases apply both to the children of low-income parents and to the children of higher-income parents. Time on task is the increasingly prevalent view that more time spent on educational or skill-building tasks will result in much improved educational performance. Home alone reflects worries about *latch-key children*. The increase of women in the labor force across all income levels has led to concerns that more and more children are being left in unsupervised situations during after-school hours, particularly during those 3 p.m. to 6 p.m. As noted previously, these are the hours when risky behavior is likely to occur, both among children from low-income families and among children in higher-income families (Hollister, 2003).

The two sets of concerns have been reflected in an increasing tension within the after-school movement. There are those who feel after-school programs should be closely connected to the schools, with programming primarily focused on enhanced educational performance. There are others who feel that student participants should feel a sense of ownership in the program, and have the ability to gain in self-confidence in non-academic as well as academic activities (Hollister, 2003).

Many different program structures have been developed and implemented but the reasons for the choice of structural elements are not clearly articulated (Hollister, 2003).

According to Eccles (1999), general theories of youth development exist which ultimately define healthy youth development and the key elements in such developments (Eccles & Templeton, 2001).

After-school models should include more specific sets of outcomes as well as measurable elements to assess the program’s impact. A consensus reached by practitioners, youth development advocates and youth development learners has resulted in a short list of a specific set of outcomes for after-school programs: caring and compassion, character, competence in academic, social and vocational arenas, confidence, and connection (Roth & Brooks-Gunn, 2000). With measures of the outcomes specified, a model would then indicate structural features that are designed to affect those outcomes. According to Eccles and Templeton (2001), such features are as follows:

1. Adequate provision for physical and psychological safety.
2. Developmentally appropriate levels of structure and adult supervision.
3. Supportive relationships with adults.
4. Supportive and respectful relationships among peers.
5. Opportunities to develop a strong sense of belonging.
6. Opportunities to experience mastery and mattering.
7. Opportunities to learn the cognitive and non-cognitive skills essential for succeeding in school, work, and other pro-social and institutional settings.
8. Strong positive social norms for behavior.

Through it all, after-school programs have the potential for, and a history of, engaging children in experiences that can transform their lives academically, socially, and professionally.

III. Methodology

This research study is quantitative and qualitative in nature in order to describe and make interpretations about how math and science programming can impact education and reduce achievement gaps. The purpose of the study is to examine how C-STEM, a management service organization, can provide services to assist schools with reducing achievement gaps in STEM areas. This section of the research provides a discussion of the study background, data collection procedures, participant recruitment process, participant selection criteria, post-group briefing, variables measured, statistics measurement, and limitations of the study. These steps were followed when the qualitative part of this study was undertaken:

1. Experiencing – through observation and field notes.
2. Enquiring – when the learner asks.
3. Examining – using and making records.

Some research advocates the mixed methodology design. According to Taylor (2000), utilizing both methods can give support and validation to the research findings by using both deductive and inductive methods. Quantitative data gathered for this part of the study was collected with a survey using the Likert scale.

A. Hypotheses

The two hypotheses formulated and tested as a part of this study were:

H1: There is a need for an after-school management service organization

(MSO) with a focus on assisting schools with implementing after-school STEM enrichment programs within Houston, Texas.

H2: An after-school management service organization in Houston, Texas can address the management, research, and implementation of quality hands-on enrichment activities that will increase the number of students’ interested in pursuing careers in STEM fields.

The first hypothesis states that there is a need for an after-school MSO. The MSO strategic planning process, in its development, specifically defines goals for the MSO that relates to education and training, research, underrepresented student participation, funding resources, and career placement. Thus, the survey instrument and interviews are designed to ascertain the level of community need for each service the MSO offers students and schools. In addition, responses to the research questions would provide confirmation of the second hypothesis, which states that the focus of the MSO should be implementing quality STEM enrichment activities.

B. Study Background

C-STEM Teacher and Student Support Services focused on providing project-based learning to students during the after-school hours. Project-based instruction fosters engagement, dedication, community, and skill building. This type of instruction requires a great deal of time and is a more complex form of teaching. To effectively implement quality project-based learning activities in schools, a great deal of staff training (i.e., project-based curriculum) is required and support services (i.e., teacher assistants, workshops, ordering supplies, locating skilled volunteers, partnerships, marketing, parent

involvement initiatives and locating funding sources, etc.). The after-school setting provided an excellent opportunity to engage students in projects, community, service-learning, exploration, discovery, and fun, and allows children to develop their own voice in an environment that feels different from school. The project-based learning concept in schools is astounding, and C-STEM provides schools with services that allow them to embark on this multifaceted pedagogy.

C-STEM works to eliminate barriers that some schools face with funding, project management, and building capacity through the community. The services that C-STEM provides allow schools to offer STEM enrichment on their campuses with the resources that ensure that student participants have a successful experience. The commitment to developing students that will one day join the workforce in STEM fields is the motivation behind the research study. Strengthening of the global economy in the oil and gas, information technology, off-shore, engineering, and math and science fields is the long-term goal.

C. Observational Process

According to Patton (1990), observational techniques are the most appropriate methods to gather firsthand data. Glimpses of various inter and intra-personal behaviors are provided through observation. Observation also provides the learner with the opportunity to openly explore the influence of STEM activities on students' perceptions of math and science during the interview process. The observation process enhanced the development of a more holistic perspective for the context within which student participants could view math and science. Behaviors were

examined as they related to verbal and nonverbal communication, participant engagement, and display of interest.

B. Qualitative Research Design

This study used an open-ended and interpretative qualitative research design. In this design, the interpretation and description (i.e. program structure, function, format, operation, etc.) of qualitative data derived from questions asked by the learner. Morgan (1997) has stated that qualitative data is defined as those (1) whose meanings were subjective, (2) that were rarely quantifiable, and (3) that were difficult to use in making quantitative comparisons. This qualitative methodology used the experience and intuition of the learner to describe the organizational process and structures being studied. The data collected required the learner to become very close to the problem being studied. The purpose of this qualitative study was to describe the nature, content, and context of interactions taking place among the student participants. This qualitative study sought an explanation of similarities and differences relative to participants’ perceptions toward math and science.

During the research interviews, the learner concentrated on the extent to which student participants answered questions, interacted with each other, completed projects, and demonstrated their understanding of concepts. At each meeting, the student participants were given full autonomy to share opinions, find solutions to problems, respond to questions, and demonstrate their thoughts. The underlying focus of every daily activity was to answer the following questions:

1. Is there a disparity in the academic motivation of students who participate in after-school STEM enrichment programs and their interest in pursuing careers in STEM fields?
2. Do teachers and school administrators see a need for STEM after-school enrichment?
3. How can we develop STEM after-school programs centered on problem-solving and higher-order thinking skills in order to increase underrepresented student interest in STEM careers?

Each of the three research questions listed above was presented to students using a 20 question survey (see Appendix A). The guiding questions related to the hypotheses inasmuch as the management service organization provides services to schools and students in an effort to motivate and encourage them to pursue STEM careers. The information gathered from the questions helped develop the support services that C-STEM provides to schools, administrators, teachers, students, and parents.

C. Human Subjects Protection

All of the data collected was kept confidential. The surveys, student data, interviews, and student notes have been stored in a locked file cabinet that only the learner has access to. And all files will be destroyed in five years. A backup disk and hard copies are stored in a secure location. No one will have access to the data collected. Codes were assigned to the subjects and the codebook will be destroyed after the data has been analyzed; the research is only reported in aggregate. There are no risks that the learner is aware of, and a human subject’s consent form was used for each participant (see Appendix B).

D. Data Collection Procedures

This study used various data collection techniques to conduct the action research. In this study the three E’s were used to conduct qualitative research: Experiencing, Enquiring, and Examining. There were four focus groups whose usage combined elements of collaboration, interviewing, and empowerment of participants, to capitalize on group dynamics. It is through the focus groups that the qualitative data was gathered. The focus group process is the explicit use of group interaction to generate data and insights that would otherwise be unlikely to emerge without the interactions found in a group.

This approach has been found to be most effective in homogeneous groups similar in age, social class and race (Kruegar, 1999). The focus group process involves the use of participatory interviews characterized by extensive elaboration, and open-ended questions. The interview process generally involves questions being asked from a prepared list, followed by exploration and probing (Lofland & Lofland, 1995). There were two observers used in the focus group process. It has been stated in research that having two people observing increases the quality of the data by providing a larger volume of data and by decreasing the influence of observer bias. The portfolio assessment methodology was a viable in using and making records for the qualitative part of this study. Its components are found in the key concepts Box 1.1 that follows:

Box 1.1 Components of Using and Making Records

Archival Sources	Attendance rates, retention rate, dropout rates; Standardized test scores and report cards; Journal articles.
Journals	Daily observations and analysis; Reflections; Record keeping.
Artifacts	Photographs and videotapes; Portfolios/project models of student work.

The student participants signed a media release and consent form (see Appendix C), an application for C-STEM (see Appendix D), and a human subjects form to participate in C-STEM. The media release and consent form gave C-STEM permission to print stories in the local newspaper, do live interviews on local news stations, and document participation on the C-STEM Website, www.cstem.org. The consent forms allowed students to operate tools for project constructions and permitted students to travel to STEM competitions. The human subject forms allowed C-STEM to use student and adult participant information in this research study. Video recorded interviews were organized to obtain useful information for the study. The video interviews provided the learner with the opportunity to view the perceptions of the student and adult participants in an objective manner. A great deal of information was provided through the video interviews. They also provided an opportunity to crosscheck data for reliability.

During each meeting with the student participants, there were two individuals, including the learner, who made observations. These observations were either noted or discussed for clarity. The focus group in this research study met five days a week for two hours daily, and some Saturdays during the academic calendar year. The participants were randomly selected to participate in the study from a total population of 51, a

convenience sampling approach. Each of the participants was asked the same questions. This process provided more information and was used to crosscheck data reliability. The internal-consistency method was used to show reliability. Internal consistency is a form of reliability of a subjective measurement instrument. The internal consistency method guarded the research study by eliminating learner influences on people’s responses, participant selection and data analysis. This method also guarded against personal attribute effect, unintentional expectancy effect, and observational biases. It provided manipulation checks and controlled for environmental influences. All internal consistency methods have one thing in common -- the subjects completed one instrument one time (Carmines & Zeller, 1979).

The data gathered were from primary and secondary sources. Primary sources are such things as participant’s academic grades, demographic records, standardized test scores, and instructional materials. Secondary sources are the participants and literature readings. The learner used secondary sources for gathering data focusing primarily on students that participate in STEM enrichment.

In order for the learner to quantify data, a survey instrument was used (see Appendix A). This instrument consisted of a set of questions based on the Likert scale to gather the quantitative data for this study. The survey instrument permitted the learner to gather the perceptions of student participants, teachers, administrators, parents, and volunteers in order to compare this information as it related to STEM enrichment and C-STEM. The survey provided an opportunity for the learner to examine and analyze the participant data from this investigation. As a research paradigm, a survey design is

concerned with discovering relationships between sociological and psychological variables. Additionally, a survey design might be used to assess the attitudes, perceptions, beliefs, opinions, and behaviors of a group of individuals toward a phenomenon (Kerlinger, 1986). According to Kerlinger (1986), there are many different kinds of survey designs. When used in educational research, surveys have the advantage of obtaining a great deal of information from a large population, provided, of course, that the survey research information is accurate within a sampling error (Kerlinger, 1986). Consequently, surveys may be conducted by personal interviews and mailed questionnaires (Kerlinger, 1986).

The student's perceptions of math and science were collected quantifiably using the Likert scale. A discussion was held in reference to the survey: the study participants were asked to complete the surveys and to turn them in before they left for the day. Consent to use this instrument was given by the doctoral committee when the learning agreement was accepted and approved. Like the interview, the survey corresponds with the research questions, and called on participants to rate their attitudes toward the information being asked in the survey using the number choices provided. This helped to provide validity and reliability to the study. The instrument validity is demonstrated by content-related evidence, also known as face validity. In the area of face validity, a specialist in the measured content is asked to judge the appropriateness of the items on the instrument (Creswell, 2001). In this instance, the learner asked Dr. Ronnie Davis of Grambling State University and Texas Southern University to review the instrument used in this study for face validity. Dr. Davis acknowledged the instrument to have excellent

content and face validity.

The learner transcribed the video recorded interviews (see page 44) and interpreted the survey instrument. To investigate the three research questions for this study, 27 student participants were interviewed and surveyed, five teachers and administrators were interviewed, three parents were interviewed, and a combined total of 21 teachers and school administrators were surveyed. The participants in the study were randomly selected from the total population of fifty-one.

A primary concern was gathering data to assess the attitudes of student participants toward STEM enrichment and its influence on their career choices. Given the focus of the study, it seemed reasonable to assume that the survey design and focus groups offered the most practical means of systematically collecting and analyzing related data. The data gathered in this study provides the reader with the perceptions of middle school students towards STEM before and after participating in the C-STEM program over a one-year period.

F. Participant Recruitment Process & Selection Criteria

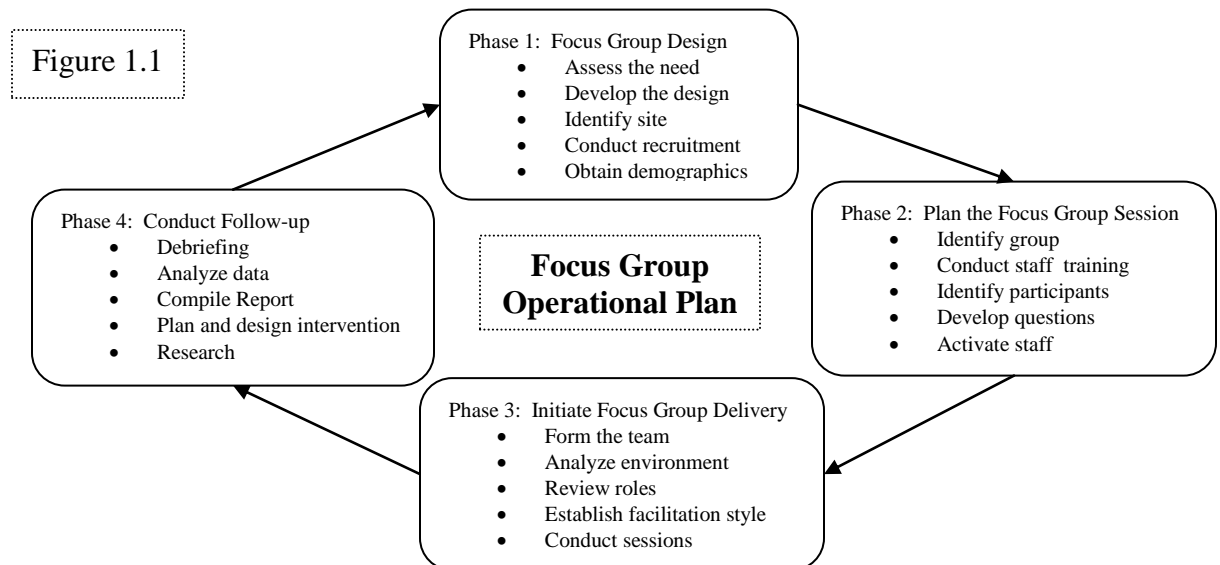
The criteria for participation required was that each participant must do the following: choose to participate in the study by his or her own free will; be a student at the participating middle school; follow the safety rules; understand the commitment and hard work necessary to stay with a STEM project from start to finish; and fit the C-STEM after-school program into his or her own schedule in the most suitable way. There were approximately 240 meeting days with the focus group in this study.

The Krueger (1994) method for participant selection was used. At the

participating middle school announcements were made, flyers were distributed and posted on the wall, and during the lunch hour and an open house, at the participating middle school, a registration table was set-up. The C-STEM after-school program operated five days a week. Participant selection required that the students have full autonomy in determining their level of participation in the program. Students completed a C-STEM application packet thereby validating their participation by obtaining their parent or guardian’s permission. A C-STEM application packet consisted of an application, a human consent form, consent and media release form, and a parent and student survey. A meeting room and times for the C-STEM after-school program were assigned and each participant was notified. The participants were responsible for showing up for the scheduled meetings on time when they were able to participate. Utilizing this method ensured that no pressure was placed on the students to attend meetings. It also allowed participants to demonstrate intrinsic motivation to become involved. The learner held the position that if students did not have to choose STEM enrichment over other extracurricular activities, for instance sports, they would figure out a way to participate in both and find the same enjoyment and interest in both. Each C-STEM session was scheduled for two hours but there were numerous sessions that lasted for as long as five hours. Student participation was limited to 20-25 students for several reasons: safety, to better facilitate the sessions, to be able to listen and provide feedback, and to allow everyone to be involved in the process.

There were four focus group meetings conducted each week over a 36 week period. The focus groups were conducted in one school district in one participating state.

The principal of the participating middle school identified the meeting location. The facility and environment where the focus group is conducted is important to the success of effective communication dialogue during the interview (Krueger, 1994). Data analysis was ongoing. The plan of operation for the focus group process is illustrated in **Figure 1.1**. The flow chart discusses the design, planning for the sessions, focus group delivery, and the follow-up.



The focus group was required to arrive Monday through Friday at 3:50 p.m. for each session. Each session began with the participants’ signing-in and having their snack. A hands-on enrichment activity was discussed and worked on. Questions were asked throughout the session to facilitate critical thinking and progress with meeting daily goals and objectives. The tools used for focus group meetings included a video camera, laptop computer, digital camera, and field notes. Student participants in the study received snacks, instructional materials, access, and free use of tools and construction materials.

G. Post-Group Briefing

At the completion of all focus groups, the data collection team summarized the data and identified the challenges and limitations encountered. Field notes were used to restructure and retool the next focus group session. During the data analysis period, the focus group planned an agenda for the next session in order to move their STEM project further to completion. A consensus among the focus group was reached after review of the completed summary and all STEM projects. An independent reader also analyzed the data to eliminate any biases (Krueger, 1994).

V. Findings

A. Demographic Characteristics of the Sample

There were one hundred and eighty meeting days designated for the research study that consisted of 30 student participants. The four focus group interviews were conducted during those meeting days at the participating middle school. Demographic variables used to characterize the study focus groups were ethnicity, grade level, and gender (see Chart 1.1, 1.2, and 1.3).

Chart 1.1

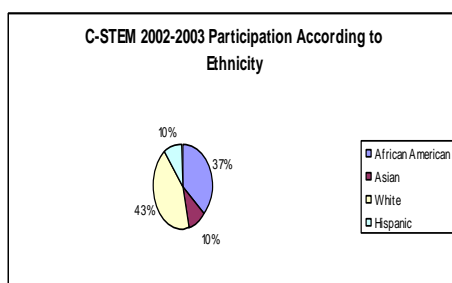


Chart 1.2

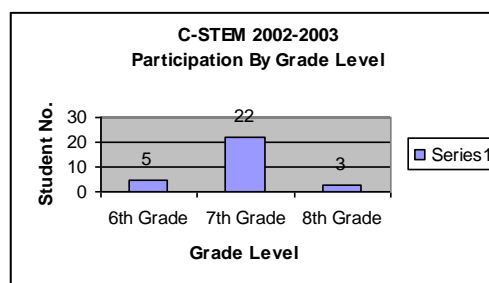


Chart 1.3

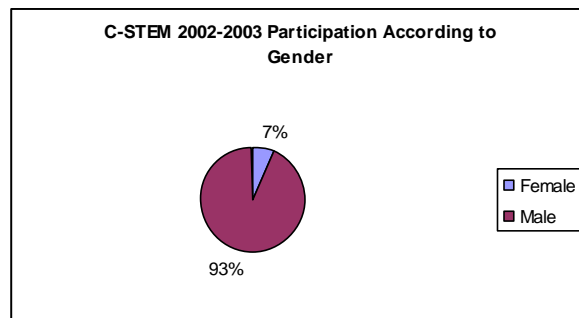


Chart 1.1 summarizes the focus groups by ethnicity. As illustrated, 37% were African American, 10% were Hispanic, 43% were White, and 10% Asian. There were 30 focus group members’ age 11-15 years and another 10 age 31-45 years (see Table 1). Most participants were male (93%) and more minority (47%) than non-minority (43%) students participated in this study.

Table 1: Focus Group Composition by Age

Age	Number
11-15	66.7%,(30)
31-45	33.3%,(10)

The focus group discussion assessed participants’ perceptions based upon the ethnic composition of the focus groups. There were four composition categories: African American, Hispanic, Female, and White. Categorizing groups in this manner allowed the data to provide an assessment of the differences in perceptions toward STEM based upon the percentages of minorities (African American, and Hispanic) in the focus group. Although the data examined the percentages of minorities, it also provided indicators of the perceptions toward STEM of non-minorities (White) in the focus group. In Table 2, student participant’s demographical information was assessed as it related to their race,

sex, special education label, enrollment in Pre-AP (Advanced Placement), math and science averages, and performance on the Texas Assessment of Knowledge and Skills (TAKS) and Stanford 10 (Standardized Test Scores).

Table 2: Student Participant Demographical Characteristics of the Focus Group 2002-2003

Student Participants	Asian	Black	Hispanic	White	Male	Female	Math Avg.	Science Avg.	TAKS/Stan	Special Education	Pre-AP
1		X				X	76	77	P/P		
2				X	X		73	79	P/P		X
3			X		X		78	82	P/F®	X	
4			X		X		77	81	P/P		X
5			X		X		92	86	F/E	X	
6				X	X		86	87	P/P		X
7	X				X		92	92	P/P		X
8				X	X		76	77	E®/P	X	
9		X			X		84	81	E®/F	X	
10				X	X		81	90	P/P		
11				X	X		91	86	P/P		X
12		X			X		83	79	P/P		X
13	X				X		87	76	P/P		
14				X	X		79	85	P/P		X
15		X			X		79	78	P/P		
16				X	X		83	75	P/P		
17				X	X		88	87	P/P		X
18				X	X		57	69	P/P		
19				X	X		85	85	P/P		
20		X			X		73	79	P/P		
21		X			X		86	88	P/P		X
22		X			X		76	75	P/P		
23		X				X	88	87	p/p		X
24				X	X		84	78	p/p		X
25				X	X		94	91	p/p		X
26		X			X		79	68	P/P		
27				X	X		89	75	P/P		X
28		X			X		92	83	P/P		X
29		X			X		86	74	P/P		X
30	X				X		77	62	P/P		X

Key

P	Passed
F	Failed
®	Reading
E	Exempted

Representative and Generalization

The National Education Association (NEA) small sampling was used to calculate the smallest sample that could be used to ensure representativeness of the Houston C-STEM program. The following is the NEA sample formula:

$$N = \frac{[X^2n(1-\Pi)]}{[d^2(N-1) + (1-\Pi)]}$$

Where:

N = the required sample size.

X^2 = the table value of Chi Square for one degree of freedom and desired confidence level.

n = population size.

Π = the population proportion which it is desired to estimate (.50 gives the maximum sample size).

d^2 = the degree or accuracy expressed as a proportion (i.e., alpha level)

Population	NEA Sample Size	Required Sample
60	29	30*

*50% return rate

Based on the NEA small sampling formula, a sample size of 30 was found to be representative of the population of students with a 50% return rate.

B. Qualitative Results

Record of C-STEM Dialogue Group

The information presented below consists of field notes from interviews of students, parents, and school administrators who volunteered to answer questions about their experiences in the C-STEM after-school program. The names of the volunteers for this interview have been changed, as well as the name of the participating school, to protect the privacy of the participants.

October 2002

Student Question 1: What type of staff do you need to support you in the C-STEM after-school program?

John: “People who have experience with using tools properly. People that are hands-on not lecturers.”

Pedro: “Someone nice... who don’t tell you how to use a tool when you already know how.”

Bret: “Someone who does not want to do everything themselves.”

Kyle: “Nothing.”

Aubry: "Good staff like Ms. Lewis."

Rodney: "Nice, kind."

Student Question 2: How were the volunteers that worked with you on C-STEM projects?

Bret: "I liked the volunteers because they were helpful with power tools and welding."

Pedro: "I thought the volunteers were cool, helped a lot, had great ideas, and I hope they are here next time."

John: "Helpful."

Rodney: "One of the volunteers taught us how to do scaled drawings. They were helpful."

Kyle: "One of the volunteers pushed you too hard and took the fun out of it."

Aubry: "I liked the volunteers."

December 2002

Student Question 1: If you could change one thing to make the C-STEM after-school program better, what would it be?

Paul: "Budget more money"

Pedro: "Make more robots like the NASA FIRST robot"

Steve: "Do more challenging projects."

John: "Do more projects that involve computer programming. Have a robot war competition against each other."

Rodney: "Do more electronic projects and design projects."

Bret: "Do more projects with computer programs to help you design stuff."

Kyle: "Nothing."

Aubry: "Compete to destroy other robots."

March 2003

Student Question 1: What do you like most about the C-STEM after-school program?

Pedro: "Building stuff."

Bret: "Experience with power tools."

Paul: "The cordless power drill."

John: "Wiring stuff."

Steve: "Ms. Flowers supervising, building things, and welding."

Rodney: "Designing, building, constructing, and electrical."

Aubry: "Watching people building stuff."

Kyle: "That you get to build stuff."

Student Question 2: What did you like least about the C-STEM after-school program?

Pedro: "Arguing and disruptive talking."

Bret: "Organization is bad."

Paul: "Non-cordless power drills."

John: "Stuff you can't wire."

Steve: "People not using your ideas."

Rodney: "Interruptions, no team work, people destroying your work."

Aubry: "Nothing."

Kyle: "Nothing."

In summary, the students completed their robotic projects, successfully competed in settings outside of school, worked along side engineering professionals, managed their

time and resources, worked cooperatively as a team to problem-solve, demonstrated their knowledge of STEM in robotic competition settings, and clearly articulated areas of service they feel C-STEM should provide. The level of student participation in the program indicates that schools can benefit from receiving STEM support and services a management service organization such as C-STEM provides. Prior to the implementation of C-STEM, the students were not provided opportunities to experience STEM project based learning in their school environment.

Transcribed Video Interviews with Individual Participants

May 2003

Student Question: Why do you like to participate in the C-STEM after-school program?

John: “I like this program because it helps you meet a lot more friends. It Helps you succeed and decide on goals.”

Aubry: “My name is Aubrey. I’m in the seventh grade and the reason I like C-STEM is because my friends are in it and we do a lot of fun stuff. We all think about how we’re going to make the robots and how we’re going to make mousetrap cars. That’s the reason I like C-STEM.”

Parent Question: What do you like about the C-STEM program?

Mary Roberts: “Hi, I’m Mary and this is my son Steve, and he’s been a member of C-STEM all year long. What I like is that it gives every child a chance to be creative and show what their talent is, even if they are not in advanced classes in science. And it makes them think and be more interested when they see a show. Like when Steve sees a show about robotics on T.V., now all of a sudden he’s looking at what that team did to

create their car and thinking for his team what could it do. He’s learned to work in a group, which is nice. He’s had to be dedicated because this program has run all year long.”

Teacher Question: What do you like about the C-STEM program?

Michael Williams: “My name is Michael Williams. I am a 6th grade science teacher here at Houston Middle School. Ms. Flowers asked me to help out with C-STEM and it’s been like a learning opportunity for me. One, because there are students already in my classroom doing it and so we got to connect on that level. Another because it just reiterates, or echoes what we learn in the classroom. Especially with the mousetrap car because it’s all about physics, force and motion. So it’s something like we talk about in the classroom and then they’re able to practice. And so I think it’s like a really good thing because they are able to practice and learn about things that they’ve done in the classroom.”

Administrator Question: What do you like about the C-STEM program?

Susan Johnson: “I’m Susan. I’m the 8th grade Dean at Houston Middle School and I am very impressed with the C-STEM program that Ms. Reagan Flowers has instituted here. The kids are very excited. I have learned quite a bit and it amazes me what the kids know and how they can really put the robots together. Going in, watching them build the robot and saying well you are on the electrical team or you are on the mechanical team, you need to do this or do that. If there’s a problem they already know how they need to fix that problem. So it is really amazing as to what they can do. And it’s a good after-school program also because when the parents come to pick the students up they are really not

ready to leave. So Ms Flowers has to spend some extra hours with them because they are so excited about this program. And to hear other people from other teams talk about what a middle school child has done, and for them to compete on the high school level here in Texas and against other schools in other states has really been amazing. I think it's an excellent program. I think she should go forth with it and expand it. The students have been excited, I have been excited, and the community has been excited. It is really an excellent program and I really wish her well in making it a part of Houston, the state of Texas or however far she can branch with it.”

John Garcia: “My name is John. I'm the principal here at Houston Middle School and here at Houston Middle School, we pride ourselves on the fact that we provide many opportunities for all kinds of kids. And I can honestly say that one of the most exciting things that happened this year has been the things surrounding the students involved with C-STEM and the students involved with Reagan Flowers. Those students have had the opportunity to grow, stretch, and come together as a team. The thing that I think is so exciting about it is that these are kids who in some cases don't have a lot of experience in working with the fantastic organizational style Ms. Flowers has brought to them, as well as the machinery and the knowledge base that was required of them in C-STEM. So these are students who basically started with very little as far as understanding, as far as what they wanted to do. But they had a desire and their desire was they wanted to work with their hands. They were interested in science and math. And taking those two interests is what they were able to do in designing and building robots and mousetrap. They were able to work together, which at grade level sixth, seventh, and eight is not always easy.

They were able to learn how to lead one another, this is very important. They learned also how to follow one another. Because of that, what we have done is turned a group of students into a group of learners and we’ve taken a group of individuals who didn’t really work all that well, into a team. And that team under the guiding leadership of Ms. Flowers has brought to this school a lot of honor and prestige. There was nothing quite as exciting as going to Reliant Arena and seeing the way that all these kids from across the country embraced our team. They were so excited about working with the young learners. Kids who have not been so successful in other areas but with C-STEM they were successful and with C-STEM they found meaning to do what they did on a daily basis in school. This was very exciting and I went and I saw the look in their eyes and the look I saw in Ms Flowers face, and the look in their sponsor’s face and it is not something I could easily forget. And it is something that keeps my batteries charged. So, I just want to say to everyone out there this is a fantastic opportunity for all types of kids and it’s been a fantastic experience for us at Houston Middle School for the kids involved.”

Individual Meeting with Expert in the Field-July 2004

Victor Cary worked with Mathematics, Engineering, and Science Achievement (MESA) for more than 10 years and is currently a consultant with the Coalition of Essential Schools. MESA is part of a national initiative promoting educational enrichment for pre-college students from historically under-represented ethnic groups. Its mission is similar to that of C-STEM; the organization prepares students for college and careers in mathematics, engineering, science and related fields. The activities that

MESA offers include tutoring; independent study; academic, university and career counseling; field trips; competitions; leadership development; summer programs; and scholarship incentives. Knowing that Victor Cary worked with the organization, I felt honored to be in attendance at a conference in Killington, Vermont where Mr. Cary was a guest speaker. After Mr. Cary's presentation at the conference, I solicited his viewpoint about my research. The following notes are from the meeting we had in July 2004.

Reagan Flowers: "I did some research on the organization MESA because it is the only organization that I can find that is similar in goals with what I am trying to accomplish with C-STEM. In my research I found that MESA is located in New Mexico."

Victor Cary: "That is not true. MESA is statewide. Matter of fact, it's located in approximately 12 states. You may want to look up Michael Aldaco. He heads up the MESA program in California."

Reagan Flowers: "I would like to improve the C-STEM after-school program to make it more effective." (I summarized for Mr. Carey what the goals of C-STEM are and how the program is implemented.)

Victor Cary: "You should look at your design. How is your program connected to the school -- during the day, after-school, and off-site? Is socialization time built into the program such as that of a university? Do you offer a summer program? You may want to implement a boot camp from 8-5 over a 6 week period. There should be concentrated time, immersion -- raise the bar. Use full court press with your students. Integrate into your program from a systemic point of view: advocates and community demands. Your program is an appendage to the system."

Reagan Flowers: “Are there others in the field that I should research that will be of aid to what I am doing with my program?”

Victor Cary: “You should look up Linda Darling Hammond. She is a professor at Stanford. There is a book you should read, *How Policy is made*.

Reagan Flowers: “What do you feel I need to focus on?”

Victor Cary: “The areas to be addressed in doing the work we do are with policy, practices, and people. Patience is urgency. There are socio-psychological dimensions of the work that has to be considered. There is internalized oppression that disrupts the Black community. There is systemic oppression where racism is held in place by class. In order to make progress with the work we do, you need to understand what is the same or different in the owning, middle, and working class. You need to also read, *Classism through Schooling*. The issues are so broad you have to have patience to continue the work we do to inspire others to pick-up where we leave off. I am just glad to see a young person such as yourself doing what you are doing.”

Individual Interview with a Potential Corporate Sponsor of C-STEM-May 2004

In the spring of 2004, a representative from Shell, the oil and gas company, was invited to visit the after-school program. During the visit the Shell representative shared the following information with me:

“In order for Shell to consider giving funding to your program, I’d like to see previous models of robots. I’d like to know the benefits as far as recognition, scholarships, etc. I’d like to know the type of field trips would you go on. I’d like to know how much money you would need to put into the program. I’d like to see how friendships are made and social life increases. I’d like to know how much fun it is to be a part of a team. I’d like to see that it is somewhat of a challenge and I’d like to know how it helps in academics.”

The proposal was submitted to Shell in June 2004 and the proposal was funded in January 2005. A copy of the submitted proposal can be found in Appendix E.

C. Quantitative Results

Research Hypothesis One: There is a need for an after-school management service organization that focuses on assisting schools with implementing a STEM after-school enrichment program in Houston, Texas.

Inferential information, using the chi square of independence, was used to ascertain the need for an after-school management service organization that focuses on assisting schools with implementing STEM after-school enrichment programming in Houston, Texas. The need for implementing an after-school enrichment program was measured by items 4, 5, 6, and 7 on the survey. These items reflected the feelings of school staff and students regarding the following statements: (1) “Teachers see a need for STEM afternoon enrichment;” (2) “Administrators see a need for STEM after-school enrichment;” (3) “Teachers should share with students the need to participate in a STEM after-school enrichment program;” and (4) “Administrators should share with students the need to participate in a STEM after-school enrichment program.” The response categories range from 1 (strongly disagree) to 5 (strongly agree).

Need by Teachers

Shown in Table 1 are the chi-square results regarding the need of teachers for a STEM after-school enrichment program as perceived by school staff and students. There was not a significant difference between the two groups, $X^2(4, N=27) = 4.82, p>.05$. Similarly, 67% of the school staff agreed with this statement and a little over 71% of the

students strongly agreed or agreed with this statement.

Table 1

Chi Square Results Regarding the Need by Teachers for STEM After-School Enrichment Program as Perceived by School Staff and Students

Group Status	Strongly Agree	Agree	Strongly Disagree	Disagree	No Opinion	Total
STAFF						
Number	0	4	0	1	1	6
Percent	0.0	66.7	0.0	16.7	16.7	100.0
STUDENTS						
Number	7	8	3	2	1	21
Percent	33.3	38.1	14.3	9.5	4.8	100.0
TOTAL						
Number	7	12	3	3	2	27
Percent	25.9	44.4	11.1	11.1	7.4	100.0

$X^2 = 4.82$; $df = 4$; $p > .05$

Need by Administrators

Reported in Table 2 are the chi-square statistic findings regarding the need of administrators for a STEM after-school enrichment program as perceived by school staff and students. There was a statistically significant difference between the perceptions of school staff and students, $X^2 (4, N=27) = 14.68$, $p < .01$. Fifty percent of the school staff agreed that administrators understand there is a need for STEM after-school enrichment programs, as compared with 81% of the students. Therefore, students were significantly more likely to perceive favorably the need of administrators for a STEM after-school enrichment program.

Table 2

Chi-Square Results Regarding the Need by Administrators for STEM After-School Enrichment Program as Perceived by School Staff and Students

Group Status	Strongly Agree	Agree	Disagree	Strongly Disagree	Opinion	Total
STAFF						
Number	1	2	0	2	1	6
Percent	16.7	33.3	0.0	33.3	16.7	100.0
STUDENTS						
Number	13	3	5	0	0	21
Percent	61.9	14.3	23.8	0.0	0.0	100.0
TOTAL						
Number	14	5	5	2	1	27
Percent	51.9	18.5	18.5	7.4	3.7	100.0

$X^2 = 14.685$; $df = 4$; $**p < .01$

Need for Teachers to Share with Students

A random survey of 21 students and 6 school staff members was done to ascertain how they perceived the statement, “Teachers should share with students the need to participate in a STEM after-school enrichment program.” Among the students, 85% reported they agreed with this statement while 14% disagreed. Among the school staff members, 67% agreed with the investigative item and 33% disagreed. Chi-square analysis of this distribution indicated a significant difference ($X^2[df=3]=8.76$, $p<.05$). Thus, students were significantly more likely to perceive a need for teachers to share with students concerning the participation in a STEM after-school enrichment program.

Table 3

*Chi Square Results Regarding the Need for Teachers to Share with Students with Respect to Participating in a STEM After-School Enrichment Program as Perceived by School Staff and Students

Group Status	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
STAFF					
Number	1	3	0	2	6
Percent	16.7	50.0	0.0	33.3	100.0
STUDENTS					
Number	9	9	3	0	21
Percent	42.9	42.9	14.3	0.0	100.0
TOTAL					
Number	10	12	3	2	27
Percent	37.0	44.4	11.1	7.4	100.0

$X^2 = 8.775$; $df = 3$; $*p < .05$

*The “No Opinion” category was eliminated due to no responses by the participants

Need for Administrators to Share with Students

A 2x4 chi-square analysis was performed to investigate the need for administrators to share with students with respect to participating in a STEM after-school enrichment program as perceived by school staff and students. Fifty percent of the school staff agreed with administrators sharing with students about the after-school enrichment program and 50% disagreed. By contrast, 81% of the students agreed and 19% disagreed. A significant difference was found between the two groups $X^2 (3) = 10.80$, $p < .01$. Consequently, students were more likely to favor administrators sharing with students the need for a STEM after-school enrichment program.

Table 4

*Chi-Square Results Regarding the Need for Administrators to share with Students with Respect to Participating in a STEM After-School Enrichment Program as perceived by School Staff and Students

Group Status	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
STAFF					
Number	0	3	1	2	6
Percent	0.0	50.0	16.7	33.3	100.0
STUDENTS					
Number	11	6	4	0	21
Percent	52.4	28.6	19.0	0.0	100.0
TOTAL					
Number	11	9	5	2	27
Percent	.7	33.3	18.5	7.4	100.0

$X^2 = 10.800$; $df = 3$; $**p < .013$

*The “No Opinion” category was eliminated due to no responses by the participants.

Research Hypothesis Two: An after-school management service organization in Houston, Texas should address the management, research, and implementation of quality hands-on enrichment activities to increase the number of students’ interested in and successful at pursuing careers in STEM fields as perceived by school staff and students.

Inferential results using the chi-square statistic were used to examine the management research and implementation of quality hands-on enrichment activities that will increase the number of students’ interested in and successful at pursuing careers in STEM fields as perceived by school staff and students. The management aspect of hands-on enrichment activities was measured by item 15 on the survey. This item reflected the feelings of the respondents regarding the statement “Students learn science and math from participating in STEM after-school programs.” This item was scored on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree).

The research aspect of hands-on enrichment activities was measured by items 9, 10, 11, 12, 13, and 14 on the investigative survey. These items reflected the feelings of participants regarding the statements: (1) “STEM after-school programs that are centered on problem solving develops student interest in STEM careers;” (2) “STEM after-school programs that are centered on higher order thinking skills develop student’s interest in STEM careers;” (3) “Students’ participation in a STEM after-school program improves academic performance in class;” (4) “Students’ participation in a STEM after-school program improves student’s conduct in class;” (5) “Students’ participation in a STEM after-school program improves students’ attendance at school;” (6) “Students’ participation in a STEM after-school program prevents students from getting into trouble.” Responses are indicated on a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The implementation aspect of hands-on enrichment activities was measured by items 1, 2, 3, and 16 of the survey instrument. The participants were asked to rate how they felt about the statements: (1) “The academic motivation of students to participate in after-school science, mathematics, technology, engineering, and mathematics (STEM) programs is low;” (2) “Your academic motivation to participate in after-school STEM enrichment is high;” (3) “Lack of academic motivation prevents students from participating in after-school STEM enrichment programs;” and (4) “Students enjoy participating in a STEM after-school program.” The respondents rated these items using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Research Aspect

Reported in Table 6 are the chi-square results reflecting the perceptions of school staff and students regarding the statement, “STEM after-school programs that are centered on problem solving develop students’ interest in STEM careers.” No statistically significant difference was found between the two groups, $X^2 (4) = 8.53$, $p > .05$. Even though a significant difference was not found, 66% and 81% of the school staff and students respectively agreed with this statement. Nevertheless, 33% of the staff disagreed with this item and 14% disagreed.

Additionally, when the two-sample chi-square test was computed with respect to how school staff and students perceived the question, “STEM after-school programs that are centered on higher order thinking skills develop students’ interest in STEM careers.” (See Table 7), no significant difference was found between the two groups, $X^2 (4) = 8.05$, $p > .05$. Half of the school staff agreed with this item compared with 81% of the students. However, 19% of the students disagreed with this item and 17% of the staff disagreed.

Illustrated in Table 8 are the chi-square results regarding the perceptions of school staff and students with respect to the statement, “Students participation in a STEM after-school program improves academic performance in class.” No significant difference was found between the perceptions of school staff and students, $X^2 (4) = 5.59$, $p > .05$. Nevertheless, 50% of the school staff agreed with this question and 33% disagreed. In comparison, 81 percent of the students agreed while 19 percent disagreed.

As shown in Table 9, when the 2x5 chi-square was calculated regarding how school staff and students perceived student’s participation in STEM after-school

programs with regard to improving conduct in class, a significant difference was found between the two groups, $X^2 (3) = 7.78, p > .05$. Half of school staff and 62% of students agreed that participating in an after-school program will improve the academic performance of students in class. Also, 17% of school staff disagreed with this item and 38% of students. Accordingly, students were more likely to feel that participating in a STEM after-school program would improve conduct in class.

Reflected in Table 5 are the chi-square findings relative to the school staff and students’ perceptions regarding the statement: “Students learn science and math from participating in STEM after-school programs.” There was no significant difference found between the staff and student groups, $X^2 (3) = .336, p > .05$. Sixty-six percent of the school staff and 76% of the students agreed that learning science and math was an important element in participating in STEM after-school programs.

Table 5

*Chi-Square Results Regarding Student Learning Science and Math from Participating in STEM After-School Program as Perceived by School Staff and Students

Group Status	Strongly Agree	Agree	Disagree	No Opinion	Total
STAFF					
Number	2	2	1	1	6
Percent	33.3	33.3	16.7	16.7	100.0
STUDENTS					
Number	9	7	3	2	21
Percent	42.9	33.3	14.3	9.5	100.0
TOTAL					
Number	11	9	4	3	27
Percent	40.7	33.3	14.8	11.1	100.0

$X^2 = .336; df = 3; p > .05$

*The “Strongly Disagree” Category was eliminated due to no responses by the participants.

Table 6

Chi-Square Results Regarding the STEM After-School Program centered on Problem Solving as Perceived by School Staff and Students

Group Status	Strongly Agree	Agree	Disagree	Strongly Disagree	No Opinion	Total
STAFF						
Number	2	2	0	2	0	6
Percent	33.3	33.3	0.0	33.3	0.0	100.0
STUDENTS						
Number	11	6	3	0	1	21
Percent	52.4	28.6	14.3	0.0	4.8	100.0
TOTAL						
Number	13	8	3	2	1	27
Percent	48.1	29.6	11.1	7.4	3.7	100.0

$X^2 = 8.530$; $df = 4$; $p > .05$

Table 7

Chi-Square Results Regarding STEM After-School Programs Centered on Higher Order Thinking Skills as Perceived by School Staff and Students

Group Status	Strongly Agree	Agree	Disagree	Strongly Disagree	No Opinion	Total
STAFF						
Number	2	1	1	0	2	6
Percent	33.3	16.7	16.7	0.0	3.3	100.0
STUDENTS						
Number	9	8	3	1	0	21
Percent	42.9	38.1	14.3	4.8	0.0	100.0
TOTAL						
Number	11	9	4	1	2	27
Percent	40.7	33.3	14.8	3.7	7.4	100.0

$X^2 = 8.050$; $df = 4$; $p > .05$

Table 8

Chi-Square Results Regarding the Student’s Participation in a STEM After-School Program Improves Academic Performance in Class as Perceived by School Staff and Students

Group Status	Strongly Agree	Agree	Disagree	Strongly Disagree	No Opinion	Total
STAFF						
Number	1	2	2	0	1	6
Percent	16.7	33.3	33.3	0.0	16.7	100.0
STUDENTS						
Number	9	8	3	1	0	21
Percent	42.9	38.1	14.3	4.8	0.0	100.0
TOTAL						
Number	10	10	5	1	1	27
Percent	37.0	37.0	18.5	3.7	3.7	100.0

$X^2 = 5.593$; $df = 4$; $p > .05$

Table 9

*Chi-Square Results Regarding the Student’s Participation in a STEM After-school Program Improves Student Conduct in Class as Perceived by School Staff and Students

Group Status	Strongly Agree	Agree	Disagree	No Opinion	Total
STAFF					
Number	1	2	1	2	6
Percent	16.7	33.3	16.7	33.3	100.0
STUDENTS					
Number	5	8	8	0	21
Percent	23.8	38.1	38.1	0.0	100.0
TOTAL					
Number	6	10	9	2	27
Percent	22.2	37.0	33.3	7.4	100.0

$X^2 = 7.779$; $df = 3$; $*p < .05$

*The “Strongly Disagree” Category was eliminated due to no responses by the participants

A chi-square test of independence (See Table 10) was used to determine whether a difference exists between the perceptions of school staff and students regarding the

statement, “Students participation in a STEM after-school program improves students’ attendance at school.” No difference was found between the two groups, $X^2(4) = 4.24$, $p > .05$. Thus, 50% of the school staff and 62% of the students agreed with this item. A little over 33% of the students and 17% of the school staff disagreed with this item.

When the chi-square statistic (see Table 11) on how school staff and students perceive students’ participation in a STEM after-school program relative to preventing students from getting into trouble was calculated, a significant difference was found, $X^2(4) = 9.85$, $p < .05$. Fifty percent of the staff and 71% of the students agreed with this item, respectively. Therefore, the perceptions of students were more favorable than school staff regarding the importance of STEM after-school programs in preventing students from getting into trouble.

Table 10

Chi-Square Results Regarding the Student’s Participation in a STEM After-School Program Improves Student Attendance as Perceived by School Staff and Students

Group Status	Strongly Agree	Agree	Disagree	Strongly Disagree	No Opinion	Total
STAFF						
Number	1	2	1	0	2	6
Percent	16.7	33.3	16.7	0.0	33.3	100.0
STUDENTS						
Number	5	8	5	2	1	21
Percent	23.8	38.1	23.8	9.5	4.8	100.0
TOTAL						
Number	6	10	6	2	3	27
Percent	22.2	37.0	22.2	7.4	11.1	100.0

$X^2 = 4.243$; $df = 4$; $p > .05$

Table 11

Chi-Square Results Regarding the Student’s Participation in a STEM After-School Program Prevents Students from Getting Into Trouble as Perceived by School Staff and Students

Group Status	Strongly Agree	Agree	Disagree	Strongly Disagree	No Opinion	Total
STAFF						
Number	1	2	0	1	2	6
Percent	16.7	33.3	0.0	16.7	33.3	100.0
STUDENTS						
Number	3	12	5	1	0	21
Percent	14.3	57.1	23.8	4.8	0.0	100.0
TOTAL						
Number	4	14	5	2	2	27
Percent	14.8	51.9	18.5	7.4	7.4	100.0

$X^2 = 9.849$; $df = 4$; $*p < .05$

Implementation Aspect

Table 12 shows the chi-square results regarding how school staff and students perceive the statement, “The academic motivation of students to participate in an after-school science, mathematics, engineering, and technology (STEM) program is low.” No significant difference was found between the two groups $X^2 (4, 27) = 2.65$, $p > .05$. Nonetheless, 50% of the school staff and 62% of students agreed with this item, respectively. Thirty-three percent of students as well as 33% of staff disagreed with this item.

Shown in Table 13 are the chi-square independence findings regarding how school staff and students perceive the question, “Your academic motivation to participate in after-school STEM enrichment is high.” No significant difference was found between the two groups, $X^2 (3) = 5.11$, $p > .05$. Even though a significant difference was

not found, 81% of the students agreed with this item and 33% of the staff agreed.

Table 12

Chi-Square Results Regarding the Low Academic Motivation of Students to Participate in the STEM After-School Program as Perceived by School Staff and Students

Group Status	Strongly Agree	Agree	Disagree	Strongly Disagree	No Opinion	Total
STAFF						
Number	1	2	2	0	1	6
Percent	16.7	33.3	33.3	0.0	16.7	100.0
STUDENTS						
Number	7	6	4	3	1	21
Percent	33.3	28.6	19.0	14.3	4.8	100.0
TOTAL						
Number	8	8	6	3	2	27
Percent	29.6	29.6	22.2	11.1	7.4	100.0

$$X^2 = 2.652; df = 4; p > .05$$

Table 13

*Chi Square Results Regarding the High Academic Motivation of Students to Participate in the STEM After-school Program as Perceived by School Staff and Students

Group Status	Strongly Agree	Agree	Disagree	No Opinion	Total
STAFF					
Number	1	1	2	2	6
Percent	16.7	16.7	33.3	33.3	100.0
STUDENTS					
Number	7	10	2	2	21
Percent	33.3	47.6	9.5	9.5	100.0
TOTAL					
Number	8	11	4	4	27
Percent	29.6	40.7	14.8	14.8	100.0

$$X^2 = 5.106; df = 3; p > .05$$

*The “Strongly Disagree” category was eliminated due to no responses by participants

Reported in Table 14 were the 2x5 chi-square results regarding how school staff and students perceive the statement, “Lack of academic motivation prevents students

from participating in after-school STEM enrichment programs.” No significant difference was found between the perceptions of the two groups, $X^2(4) = 4.10$, $p > .05$.

Sixty-seven percent of the staff and 76% of the students agreed with this item.

Table 14

Chi-Square Results Regarding the Lack of Academic Motivation Prevents Students from Participating in After-School STEM Enrichment Programs as Perceived by School Staff and Students

Group Status	Strongly Agree	Agree	Disagree	Strongly Disagree	No Opinion	Total
STAFF						
Number	1	3	1	1	0	6
Percent	16.7	50.0	16.7	16.7	0.0	100.0
STUDENTS						
Number	11	5	2	1	2	21
Percent	52.4	23.8	9.5	4.8	9.5	100.0
TOTAL						
Number	12	8	3	2	2	27
Percent	44.4	29.6	11.1	7.4	7.4	100.0

$X^2 = 4.098$; $df = 4$; $p > .05$

Finally, the Chi Square results (See Table 15) regarding the perceptions of school staff and students toward enjoying participation in a STEM after-school program. A statistically significant difference was not found between the two groups, $X^2(3) = 2.26$, $p > .05$. Sixty-eight percent of the school staff and 81% of the students agreed that participation in a STEM after-school program was enjoyable. Seventeen percent of the staff and 14% of the students disagreed.

Table 15

*Chi-Square Results Regarding Students Enjoying Participating in a STEM After-School Programs as Perceived by School Staff and Students

Group Status	Strongly Agree	Agree	Disagree	No Opinion	Total
STAFF					
Number	3	1	1	1	6
Percent	50.0	16.7	16.7	16.7	100.0
STUDENTS					
Number	16	1	3	1	21
Percent	76.2	4.8	14.3	4.8	100.0
TOTAL					
Number	19	2	4	2	27
Percent	70.4	7.4	14.8	7.4	100.0

$X^2 = 2.258$; $df = 3$; $p > .05$

*The “Strongly Disagree” category was eliminated due to no responses by participants

The survey instrument used for the quantitative findings noted in this section of the research study was content-validated by Ronnie Davis, Ph.D. Dr. Davis is a professor at Texas Southern University and Grambling State University. Dr. Davis teaches SPSS (Statistical Package for the Social Sciences) doctoral level research courses at both universities.

C. Limitations of the Study

The learner developed research questions from multiple sources and perspectives, which included: STEM curriculum and activities; teachers’ and administrators’ roles with implementing and facilitating STEM enrichment; fundraising; leadership development; identifying appropriate staff and the role of volunteers; identifying student’s STEM interest; the role of C-STEM in providing services and support to schools in STEM areas; sustainability of STEM programs for minority students; and personal sustainability. The

participants in the study responded favorably toward the support and services provided by C-STEM which was demonstrated by the level of participation. The study was very helpful in the inquiry process; however, the learner did not create a “toolkit” or “guide book” for implementing, facilitating, and sustaining STEM project-based learning. The toolkit could be used in schools and perhaps shared with other social change organizations. This limitation in the idea of developing a “toolkit” or “guide book” did not allow C-STEM to leave schools with a curriculum plan necessary to continue the STEM enrichment outside of C-STEM and perhaps going a step further in implementing STEM project-based learning enrichment activities during the school day.

V. Discussion, Conclusions, and Recommendations

A. Discussion

C-STEM offers students learning experiences that encourage them to use their minds independently, problem solve, work successfully as a team, and learn gracious professionalism. STEM projects allow for improved student achievement, which assists schools in reducing the performance gaps in mathematics and science among a diverse student population. The qualitative and quantitative data from the study support the level of action taken by the learner. According to the learner, the educational system must move away from methodologies of the past that do not support our current workforce demands. The educational system as it exists continues to graduate disproportionate numbers of minority students who demonstrate an inability to compete in STEM fields. C-STEM offers action through the learner reflection to assist schools and organizations with transforming the way we educate and expose children to STEM. Unfortunately, the

educational impact needed to close the achievement gap cannot be accomplished by C-STEM alone. Reducing the achievement gap will take a full collaboration and partnership with both the public and private community. The implication of the findings is that C-STEM should continue to re-invent itself in order to have a fresh pair of eyes in identifying ways to best support schools with educating children in STEM. In doing so, the schools will have to support the need for STEM project-based learning and demonstrate the support within school budgets. As long as schools continue not to financially support and properly train teachers around STEM project-based learning, they will continue to get the same results.

C-STEM is dedicated to providing schools with support services to implement enrichment projects and activities in science, technology, engineering, and mathematics. The organization ensures that underrepresented students experience hands-on enrichment opportunities through project based learning primarily -- through robotics at partnering schools. According to the City of Houston Mayor’s After-school Achievement Program, there are millions of children left unattended between 3:00 p.m.-6:00 p.m. Being alone increases the likelihood that children will be drawn to illegal activities or become victims of violent crimes. C-STEM is housed on a participating school’s campus thus providing students a safe environment in which to socialize while working on innovative C-STEM projects. The program is an open admission and serves students in grades 4-12. The projects that C-STEM, Inc. has assisted schools with implementing are:

1. FIRST Robotics Competition.
2. Space City BEST Robotics Competition.
3. SECME Mousetrap, Poster, & Essay Competition.
4. Odyssey of the Mind Competition.

5. Lego Robotics.
6. Grant writing services to schools.
7. Individualized project and program development for schools.
8. Program and project evaluation.

This is validated below in research cited from For Inspiration and Recognition in Science and Technology (FIRST). C-STEM’s projects are aligned with the curriculum set forth by the Texas Essential Knowledge and Skills (TEKS), reinforcing what is being taught in participating schools. C-STEM was piloted in a middle school in Houston, Texas during the 2002-2003 academic year. To date, C-STEM has expanded to two additional schools and has received funding to expand into five additional schools during the 2005-2006 academic calendar year.

Through research with FIRST, the learner uncovered the following facts that support the efforts of C-STEM:

Students Participating in After-School Initiatives

1. 2 out of 3 students who have gone through STEM programs want to return to the program as a mentor after graduation.
2. 3 out of 4 students rate their relationship with the program sponsor as good.
3. 1 out of 2 indicated the likelihood of pursuing STEM careers at the post-secondary level.
4. In robotic competitions, approximately 26% of the participants are female, 31% belong to a racial and/or ethnic minority group, and 20% are underrepresented minorities.
5. 19% of female students who participate in robotic competitions major in engineering at the undergraduate level and 16% of underrepresented minorities major in engineering at the undergraduate level.

Benefits to Student Participants in After-School Initiative

1. Exposure and experience in hands-on, real life applications of math, reading, writing, and science taught in the classroom leads to improved student scores on the statewide Texas Assessment of Knowledge and Skills (TAKS) test.
2. Improved student attendance at school.
3. Improved student conduct and self-discipline.
4. The development of good citizenship and study skills in motivated students.

1. New experiences encourage students to graduate from high school and college in STEM fields creating a pipeline for the workforce.
2. Provision of a safe, supervised place for students to learn and socialize away from negative influences in the community.
3. Training teachers, volunteers, mentors, and parents in the best STEM enrichment opportunities that are available to children.
4. Increased student achievement and increased self-esteem.
5. Improved problem-solving skills.
6. Improvement in attitudes toward teamwork.
7. Improvement in attitudes concerning the working world.

Reasons Why Students get involved in After-School Initiative

1. To have fun.
2. For the challenge.
3. To qualify for scholarships, internships, and strengthen their chances for college success.
4. To learn more about technology.

C-STEM, Inc. has developed a program guide for the delivery and implementation of services in grades 4-12, with adequate funding. The program guide has several specific components:

1. C-STEM team planning.
2. Cooperative teaching and learning.
3. Interdisciplinary instruction.
4. Networking skills.
5. Study groups.
6. Test taking and study skills.
7. Goal setting and time management.
8. Reinforcement of basic skills.
9. Development of thinking skills.
10. Career exploration.
11. Role models and mentors.
12. Parental involvement.
13. Leadership development.
14. Community service.
15. Scholarship information and application.
16. University exploration and selection.
17. Evaluation of the program.
18. Data collection and reporting.

In addition to these common components, there are 11 groups of participants in the C-STEM program.

1. C-STEM office.
2. C-STEM partners.
3. Local business and industry.
4. Community.
5. Parents.
6. School administrators.
7. School counselors.
8. Classroom teachers.
9. Media.
10. K-12 schools.
11. Students.

At each participating school, a C-STEM staff member assist a leadership team at the participating school to plan and carry out STEM enrichment programs. A typical leadership team includes the principal, counselor, science teacher, math teacher, technologist, and language arts teacher, but other faculty is encouraged to support the leadership team and the student participants. The team roles can be described as follows:

1. C-STEM program advisor – supports leadership team, provide resources, facilitator, contact person between C-STEM partners, and motivator.
2. Principal – support, resources, and motivator.
3. Leadership team – sponsors, motivators, student mentors and recruiters.

Leadership members participate in educator leadership development, which is provided by supporting partners of C-STEM and enrichment programs that C-STEM supports. The leadership team obtains the following:

1. Details on implementing C-STEM enrichment activities in their schools.
2. Resources on specific curriculum to support enrichment activities.
3. Methods of preparation and implementation of enrichment activities.
4. Information resource on C-STEM opportunities for students at participating schools.

C-STEM student participants include students with the potential and desire to achieve.

C-STEM efforts to develop effective programs and resources include:

1. A elementary school component – grades 4-5.
2. A middle school component – grades 6-8.
3. A high school component – grades 9-12.
4. Workshops offered in local settings.
5. Scholarships.
6. Internships.
7. Access to available resources.
8. On-site support from C-STEM staff.

According to SECME, Inc. (2002), the building of a leadership team is the core to having successful STEM enrichment programs in schools.

- I. Importance
 - A. To assure successful implementation of STEM enrichment activities.
 1. Set goals and objectives
 2. Plan and implement activities
 - B. Provide resources, support, and encouragement.
 - C. Receive the full benefit of STEM.
- II. Building the team
 - A. Start with what exists and build.
 - B. Must have the support of school administrators of STEM program.
 - C. Present STEM enrichment opportunities to entire staff and student body.
- III. Leadership team members
 - A. STEM program advisor.
 - B. STEM teacher assistant.
 - C. Teacher(s).
 - D. Principal.
 - E. School staff.
 - F. Parents.
 - G. Students.

Program Processes

General

1. Students will improve scores in science, mathematics, reading, and writing on standardized tests.
2. Students will participate in supported STEM enrichment activities and competitions to improve skills.

1. Students will take field trips to gain exposure to universities/colleges, technological industries, and institutions that encourage career development in STEM areas.
2. STEM program advisor will review all available data.
3. STEM will collaborate with community organizations to sponsor science, technology, engineering and mathematics career information sessions.
4. STEM program advisor will recruit parents to serve as resource people.
5. STEM will organize, plan meetings and distribute information.
6. STEM program advisor will provide scholarship and internship information to students regarding science, technology, engineering, and mathematics.

Recruitment activities

Teachers will:

1. Provide information to students to motivate interest.
2. Utilize parents and community.
3. Utilize other school-based programs.
4. Use students as role models.

Maintenance Activities

1. Use registrar and counselors.
2. Daily, weekly, and yearly student progress reports.
3. Academic awards at the end of school term.
4. Provide incentives.
5. Ensure that qualified students are prepared to take ACT/SAT.
6. Provide access to peer and outside tutoring.

C-STEM Program Chart

WHO	WHAT	HOW
C-STEM	Workshops, training, resources, motivator, morale builder, facilitate enrichment activities, program assessment, Coordinate program, support group, guidelines, program assistance	Organize in-service, set policy and procedures, program implementation, awards, locate funding, consultants, public relations, resource materials, leadership training, participation in enrichment activities, plan activities, cooperative teaching/learning
Teacher	Team planning, team member, student support, facilitator, resource person, staff development	Work cooperatively, share knowledge and skills, networking, encourage participation, advise, tutor, coach, mentor, provide learning opportunities
Middle Schools	Career awareness, team member, Link with elementary schools, programs, tutors	6 th – 8 th grade, cooperative STEM enrichment activities
High Schools	Career information, link with middle schools, resource, tutors, mentors, link with colleges, team member	9 th – 12 th grade, share materials, peer groups, advisors for middle schools, campus tours, job shadowing, research/interviews, networking opportunities for students and teachers, interdisciplinary student learning
Students	Active participants, peer support	Engage in STEM learning activities, tutor/mentor
Community	Support STEM programs rewards and acknowledge student achievement, sponsor STEM activities, resource, volunteers, career awareness	Mentor, tutor, awards and rewards

B. Conclusions

C-STEM was incorporated as a non-profit organization, which allows the program to be funded by federal, state, and local grants. Grant funding has allowed the organization to further its mission. In its third year, C-STEM generated approximately \$250,000.00 to support after-school enrichment programs in three schools. In support of existing STEM programs, C-STEM implemented and facilitated project-based learning activities that required students to problem-solve. The STEM projects do require that students democratically conceptualize goals and objectives, develop plans and make adjustments, work as a team to make a product, and seek new learning experiences to better their product. The successful implementation of the C-STEM pilot program at a middle school in Houston, Texas has led to the program expansion into 10 additional middle and high schools.

The learner selected the middle school level to pilot the C-STEM after-school program because the students are at an age where childcare is still needed and is often unavailable because of their age. The student participants in this research study received attention, support and supervision from caring adults, which allowed them to find more success with their independence in the program. The C-STEM pilot program provided quality after-school enrichment at no cost association to the parents of student participants. There was an obvious demand for such a program because on average the organization serviced 20 to 25 students daily. The parents of all the student participants worked outside of the home. Of the total number of students serviced during this study, 40.7 percent were from single parent households and 59.3 percent were from married

couple families. The C-STEM program provided a service that closed the gap between parents’ work schedules and their child and/or children school schedule, which was approximately fifteen hours per week. The schedule gap was filled with quality STEM project-based learning activities that required the students to problem-solve. The STEM projects that the students completed during their participation in the program were entered into local competitions.

The supervised after-school hours placed C-STEM students in a positive environment far from negative influences. Students participating in the program were away from peers that participated in high-risk behaviors such as alcohol, drugs, tobacco, and gangs. The intensity and challenging nature of STEM projects occupied students’ time with constructive learning experiences that were supervised by responsible adults.

The middle school in Houston, Texas where C-STEM was piloted received a full-service, comprehensive, after-school program on their campus. C-STEM generated its own funding through the solicitation of grants and fundraisers. The organization also provided staff to work directly with the students, volunteers and mentors from STEM fields, and provided transportation to STEM competitions. The student participants received after-school snacks, and, when applicable, were provided breakfast, lunch, and dinner. The uniforms that students wore to STEM competitions were provided by C-STEM, and various field trips were sponsored. At the completion of the academic year student participants were rewarded for their academic achievement at the annual C-STEM banquet.

The C-STEM enrichment activities required that the students work collectively in

groups. In the process, students had the opportunity to improve their social skills, due to the integration of all grade levels (6th-8th) into a heterogeneous group. Demonstration of students’ improved social skills was evident with the completion of each STEM project, which always required students to work as a team and with small groups. Construction of STEM projects resulted in one finished product for competition that represented the group; in the process, students learned how to handle conflicts in more socially acceptable ways. The STEM projects made students more likely to develop and apply math, science, reading, technology, and oratory skills. The student’s involvement in STEM competition allowed them to compete against students from across the nation and at the high school level. Their involvement encouraged students to be academically successful and in some instances increased their self-esteem. The students were always given a project timeline, which helped develop their intrinsic motivation. Intrinsic motivation is necessary for students in order for them to work to complete their projects independently.

The C-STEM program recognized the social implications in its development as it relates to the various forms of capital needed to make possible student achievement for low socioeconomic ethnic minorities (African-American, Hispanic, and Native Americans). C-STEM provided the pilot school with supplemental education that supported academic learning and child development. With the C-STEM program existing at no cost to students, low-socioeconomic and ethnic minority student groups were more apt to participate in the program. With participation, such groups were more likely to increase their academic achievement levels relative to White and Asian

American mid to high socioeconomic student groups. It was the learners understanding in developing C-STEM that schools alone cannot ensure high academic achievement of all students. Supplemental education that supports academic achievement is what enables schools to work. C-STEM is structured such that it is able to compensate for parents who do not have the time or natural inclination to expose their children to high performing learning communities where serious academic work is respected, standards are explicit, and high achievement is rewarded. The C-STEM program operated outside of the school day. The normal program hours of operation were from 4:00 p.m. -6:00 p.m. Due to intensity of some of the STEM projects, students at times stayed an additional (3) hours on some days and worked on Saturday and Sundays to complete their projects. The students were exposed to formal and informal learning experiences that demanded high academic achievement.

Students involved in C-STEM would recruit their friends to participate in the program, which constantly increased enrollment. It was important to the students involved that their peers were participating in the same activities. African American, Hispanic, Indian, White, and Asian students participated in the program. The diversity of the group allowed the students to make social connections with those different from themselves. Regardless of ethnicity, every student felt a sense of belonging in the group.

The STEM projects that C-STEM implemented were topic-specific and developed problem-solving skills. Every project required the group to design, construct, and operate a working model to solve a set problem within given parameters and a certain time frame. The student group was comprised of 6th-8th grade students with which the learner has had

a three-year relationship. It is evident that the students' information processing skills, knowledge application in new learning situations and individual awareness of strengths and weaknesses has changed as they develop. The completed FIRST robotic project at the end of the third year demonstrated a tremendous new learning and understanding of math, science, and technology.

In the research study it was observed that fewer minority students were enrolled in higher-level math and science courses than non-minority students. It was noted in the research study that 42.8 % of minority and 61.5% of non-minority students were enrolled in at least one advanced placement math or science course. According to the Scientists and Engineers Statistical Data System (2000), in order to meet workforce demands for new engineers and scientists, the United States needs to utilize its entire societal makeup. It is clear that the talent pool of African Americans, Hispanics and other minorities has yet to be exploited. Progress has been made over the past 10 years in terms of increasing the population of minorities in science and engineering, but there is still much work to be done. There are several areas of concern that need to be addressed to increase the number of minorities in science and engineering. The most important area is a child's home life; this is essential to a child's value of education. Family support and encouragement promotes learning and motivates a child to excel in the classroom. Changes in early education, grades K-12, need to be made to create interest in areas of science and technology for minority students.

Today's world is driven by technological advancements made through developments in engineering and science. This force has created an explosive demand for

new engineers and technically trained people. Increasing the population of minority engineers and scientists begins with early childhood development. Children need to be educationally encouraged and supported at an early age. Much of this support needs to come from a child’s family; children must be exposed and introduced to areas of science and engineering fields. They need to feel confident that they can succeed. Such confidence comes not only from home, but from role models and mentors with whom children can identify. Those who have careers in engineering or science can convince children that they, too, can become a scientist or engineer.

SESTAT (2000) also stated that an increase in educational programs is essential to encouraging minority students to pursue careers in science and engineering. Effort in this area is so important because, “during these critical years, students must be provided adequate exposure, exciting training, and varied learning opportunities in these disciplines to believe science, engineering, and technology are viable, desirable fields” (Collins, 1997). Students need to be exposed and educated about available career opportunities, and given appropriate encouragement that they have the ability to excel in such areas. Beyond the inclusion of new programs, the basic core curriculum must be emphasized.

A high quality core curriculum must be available to all students. This includes courses that will provide a mastery of algebra, geometry, and the basic sciences for all students. At the present time not all students are undertaking such a curriculum. Incentive-based scholarships and internships for students taking higher level math and

science courses can serve as a motivator for participation. Students should also be provided support services (i.e. mentors) to assist with finding success in higher level math and science courses.

The work of C-STEM has taken STEM after-school enrichment a step further. The learner in this study has conducted research through the Department of Education and the Texas Education Agency and has not found another organization with the same mission or goals as C-STEM. There are agencies that provide after-school programs, but none with an emphasis on providing support services to implement STEM enrichment to underrepresented student groups. The organization supports existing programs that offer STEM enrichment (i.e. SECME, FIRST and Space City BEST Robotics). C-STEM provides support in the implementation of existing programs on school campuses where they do not exist. The research conducted by SESTAT (2000) shows there is a need to continue expose minority students to math and science in fun and exciting ways. C-STEM works with schools on a grassroots level to ensure successful implementation by providing hands-on support services and funding to assist schools from start to finish in implementing STEM enrichment projects after school.

During the 2004-2005 academic year C-STEM expanded into two additional schools, allowing the organization to work with both elementary and middle school students. The organization received funding from Shell to expand C-STEM to 20 additional schools during the 2005-2006 year. The support C-STEM has received from students, teacher, administrators, and community businesses has validated my two research hypotheses through this research:

- H1: There is a need for an after-school management service organization that focuses on assisting schools with implementing after-school enrichment programs in STEM areas in Houston, Texas.
- H2: An after-school management service organization in Houston, Texas should address the management, research, and implementation of quality hands-on enrichment activities that will increase the number of students’ interested in and successful at in pursuing careers in STEM fields.

The hypotheses were validated in this study when C-STEM was removed from the piloted school. In the absence of C-STEM, the school did not continue offering their students STEM after-school enrichment. The students that participated in the C-STEM program at the piloted middle school are all in high school. The high school that their middle feeds into, has since created a STEM after-school program supported by C-STEM. The students that participated in middle school spearheaded this initiative. The students contacted the learner and asked for assistance with implementing C-STEM. Before the students could garner the assistance of C-STEM, they were instructed by the learner to find a teacher sponsor. The teacher sponsor that the students identified worked with the services provided by C-STEM to successfully implement robotics after-school. The intrinsic motivation of these students validates both of the learner’s hypotheses.

The research indicated that 50 percent of the school staff that completed the research surveys agreed that administrators understand the need for STEM after-school enrichment programs. The perceptions of the school staff were reflective of the fact that before C-STEM, there were no plans for implementing STEM after-school enrichment.

The school focused more on Fine Arts. Which indicates that STEM after-school enrichment was not a school focus until it was introduced by C-STEM. The school allowing the implementation of C-STEM indicated to 50 percent of the school staff that the administrative staff does see a need for STEM after-school enrichment. The administrative staff observation of student participation and successful completion of STEM projects proved that there was a need. There were 81 percent of the student participants that agreed that administrators understand there is a need for STEM after-school enrichment programs. The administrative staff supporting the implementation of C-STEM on the schools campus as an after-school program proved to the student participants that the administrative staff saw a need for STEM after-school enrichment. The administrators often stopped by the program after-school to cheer the students on with their work, visited the STEM competitions to see them in action, and attend the end of the year awards banquet to celebrate the student’s accomplishment. The visibility of the administrative staff in support of the student’s participation in C-STEM impacted their perception that administrators see the need for STEM after-school enrichment.

After-school spaces are not quite school (although they increasingly connect to academic learning goals), yet they are not quite family (although they represent informal opportunities to provide comfort, security, and recreation). There is an emerging awareness that as society moves away from the after school, child-initiated play of the past, we must ensure that structured after-school programs allow for youth choice and voice in order to meet a child's need for autonomy. Many after-school programs facilitators also recognize the need to provide directly extended academic learning,

differentiated enrichment learning opportunities, and non-academic activities focused on physical, social and emotional development through extracurricular learning.

There is also an increasing recognition that after-school programs represent a space with great potential for innovative community partnerships. Such partnerships require knowledge of, and connection to, community-based resources and programs, as well as physical facilities. Schools, teachers, and parents cannot provide all that children need: after-school education is an emerging field that supports learning and school reform and helps connect children to their communities.

Finally, it was observed by the learner that all of the C-STEM student participants enjoyed the social interaction with their peers. C-STEM offered an opportunity for students to meet individuals with positive social values and a positive vision of their futures. Moreover, it provided a place where students felt accepted and could explore both their personal and social identities without having to continually confront racism and cultural intolerance. Students were intrigued by robotics and enjoyed the hands-on STEM projects. Such projects encouraged positive development in many areas and reduced the likelihood of student engagement in problematic behaviors. The program remediated some deficiencies in skills already evident, taught new intellectual and technical skills important for success in high school and career movement, and provided intellectually challenging experiences to foster cognitive development. C-STEM also supported continued positive socio-emotional development and established strong social connections between the kinds of individuals and social institutions that help youth to be successful during their adolescence and to make a successful transition into adulthood.

Students had opportunities to form positive relationships with individuals from STEM industries and college students. The students also had opportunities to experience first hand how they could apply what they had learned in the classroom to real life. The C-STEM program was open to any student who had an interest and provided each student participant an opportunity showcase their talents. For many of the students participating in C-STEM, it was a huge self-esteem booster; they were able to exhibit projects that they constructed with their own hands. Additionally, were expected to exhibit gracious professionalism with their peers, which is something we infused into the C-STEM program from our participation in the FIRST (For Inspiration and Recognition of Science and Technology) robotics competition. The students were constantly reminded to finish what they started and of their commitment to the team when accomplishing project goals within set timelines. Regardless of individual differences between the student participants, the students always prevailed as one unit, with each student supporting the other and assuming leadership when necessary. Every STEM project provided an opportunity for students to build skills as it related to understanding of how to work with different materials, how to operate various tools, how to design and create an object to solve a specified problem, how to communicate creations to specialists from industry both written and verbal, and how to work with others different from themselves. Families were allowed to participate in the entire process for each STEM project and helped with fundraising, assisting with constructing projects, motivation, encouraging

team spirit, chaperoning, and soliciting others’ to support the students. The middle school that piloted C-STEM was supportive of the students as well. The school supplied an area for C-STEM staff to work with the students on campus at no cost to the organization and showcased the student’s accomplishments to the school community. The C-STEM program was supported by partnering corporations and organizations, and such as Shell, the American Society of Mechanical Engineers, Beststaff Technical Services, Texas Southern University, and University of Houston. These organizations provided funding, volunteers, and staff to work with the students. The overall success of C-STEM as an action research project is demonstrated by the growth C-STEM has achieved over a three year time period. As of spring 2005, C-STEM has formed a partnership with 23 public schools in Houston, Texas to implement STEM after-school enrichment programs with an emphasis on robotics. The ultimate expectation is to attract more brilliant young minority students to STEM careers. C-STEM is just one of many initiatives needed to increase the number of minorities entering math and science fields.

C. Recommendations

Through the implementation of C-STEM three hands-on projects were undertaken in the first year: two robot competitions and a mousetrap car competition. This learner realized after attending a workshop on designing curriculum that, for everything that this learner wanted the student participants to learn through their experience with C-STEM, the organization needed to focus on one project for the entire year. It appeared that robots intrigued the students the most; building mousetrap cars, writing essays, and

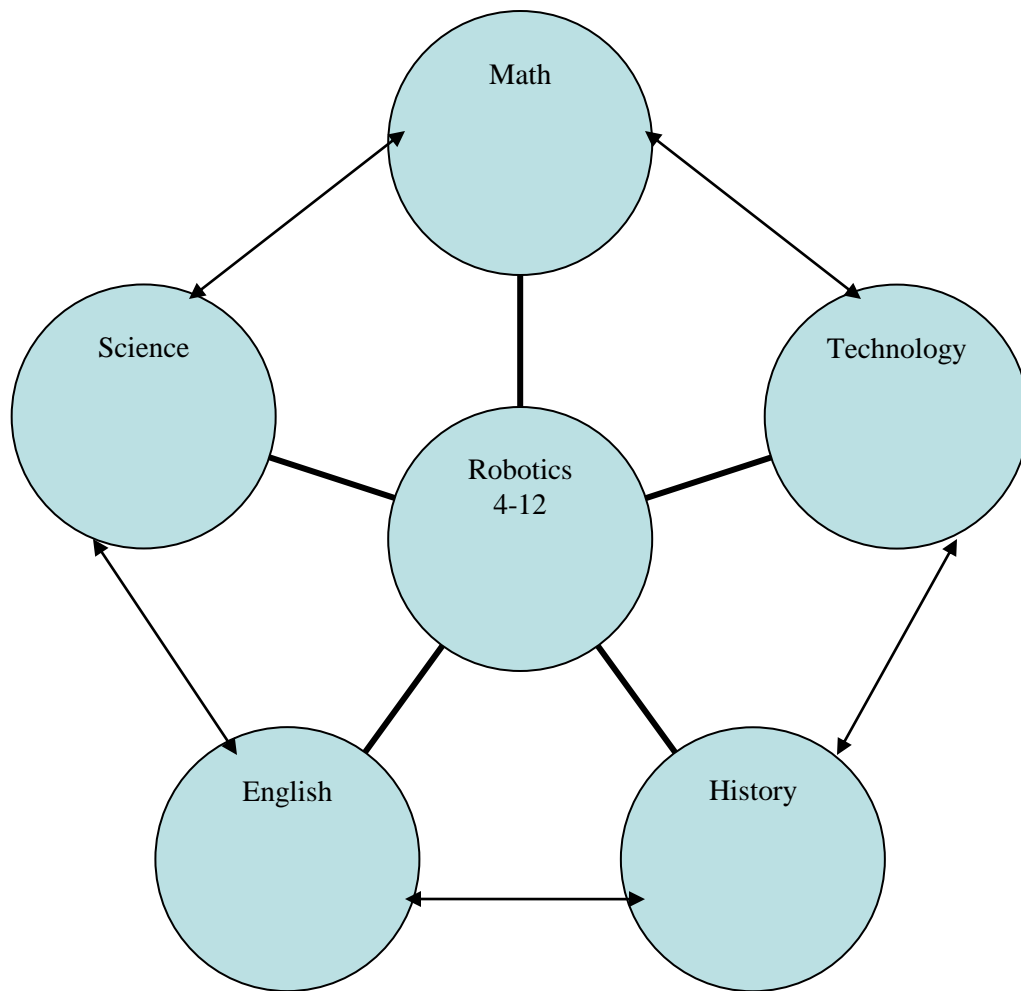
designing posters were secondary. In order for C-STEM to make robotics its main focus area, the learner designed a curriculum model. The curriculum model was intended to be utilized as a plan or program for all of the students under the instructional leadership of C-STEM. The curriculum consists of a number of plans, in a written form with varying scope, which delineates the learning expectation. The specified curriculum model illustrated below may be utilized as a unit, a course, a sequence of courses, or as an entire program of study. The curriculum is interdisciplinary in that it covers all of the core content academic areas and ideally, it should be instituted outside of the classroom during after-school programming hours.

A recommendation for improving the C-STEM after-school program is to create a curriculum guide, addressing robotics education for teachers and students. The National Science Foundation (2005) surveyed educators and found that many teachers do not feel prepared to help their students explore the engineering profession. The curriculum guide would be developed as a teaching manual that shows the interdisciplinary aspects of STEM as well as the connection to Texas educational standards, Texas Essential Knowledge and Skills (TEKS). The curriculum guide should also be written at the higher levels of Blooms Taxonomy, synthesis and evaluation. The curriculum guide will provide a framework for educators to introduce STEM project-based learning not only after-school but also during the course of an instructional day. In doing so, more students would have the opportunity to apply what is being learned in math and science to real life. The guide would be written to include vendors for purchase of STEM kits, alignment of STEM kits with the TEKS, explain the use and functionality of the STEM

kits, outline how to integrate STEM kits into the classroom/after-school, provide a listing of STEM competitions that the students can enter, list funding sources for purchase of instructional materials and STEM competition entry fees, provided recommendations on the level of knowledge skills the students need to have in math and science, and provide information on how schools can involve their communities in the STEM project-based learning experiences with their students. It is recommended by the learner that the curriculum guide be developed for further study on impacting STEM education during the academic day as opposed to just an after-school focus. In closing, the learner also recognizes the research was conducted using a small sample and recommends that other learning communities apply the C-STEM Curriculum Model to a larger sample population. The C-STEM Curriculum Model would cover the following content areas:

C-STEM Curriculum Model

- I. Theme: Robotics
- II. Outcomes:
 - 1. Investigate robotics.
 - 2. Design a project.
 - 3. Create a solution to a real life problem with the project.
 - 4. Analyze, make, and defend predictions and recommendations.
- III. Project: Interdisciplinary



Math

- ~Addition, subtraction, division, and multiplication
- ~Measurement
- ~Formulas/equations
- ~Problem-solving
- ~Budget

English

- ~Business plan
- ~Portfolio
- ~Technical Reports & oral presentations
- ~Reading and comprehension
- ~Literature and multimedia

Science

- ~Gears, levers, pulleys, simple machines
- ~Physical properties
- ~Materials
- ~Scientific laws
- ~Medical usage of robots

Social Studies

- ~Robotics evolution
- ~History of robotics
- ~Robot literature and media

Technology

- ~Website development
- ~Computer programming
- ~Computer animation and design

IV. Outcome Statements

(The outcome statements below express the desired learning outcomes for student participants in the C-STEM program.)

1. Students will investigate robots in various forms of media (fiction/real life). **(analysis)**
2. Students will design a project in a medium that has been learned. **(synthesis)**
3. Students will create a solution to a real life problem, determine and justify best possible solutions and subsequent implications in order to then make recommendations. **(synthesis)**
4. Students will analyze relationships and interactions to draw conclusions. They will then make and defend predictions and recommendations. **(analysis)**
5. Students will evaluate commonalities, differences, and connections between significant concepts and their relationships including real life examples. **(evaluation)**
6. Students will compare the effects of the advantages and disadvantages of robotics in order to make predictions and recommendations with respect to the past, present, and future. **(evaluation)**

V. Outcome Demonstrations

(The outcome demonstrations are the expected ability levels of the student participants in the C-STEM program.)

Students will demonstrate the following:

1. Verbal, quantitative, and technological literacy.
2. Skills in communications and group interaction.
3. Problem-solving and design making.
4. Skills in creative expression and responding to the creative works of others.
5. Civic understanding through the study of American culture and history.
6. Understanding of past and present cultures.
7. Concern, tolerance, and respect for others.
8. Skills in adapting to and creating personal and social change.
9. Capacity for enhancing and sustaining self-esteem through emotional, intellectual, and physical well-being.
10. Skills necessary to be self-directed learners.

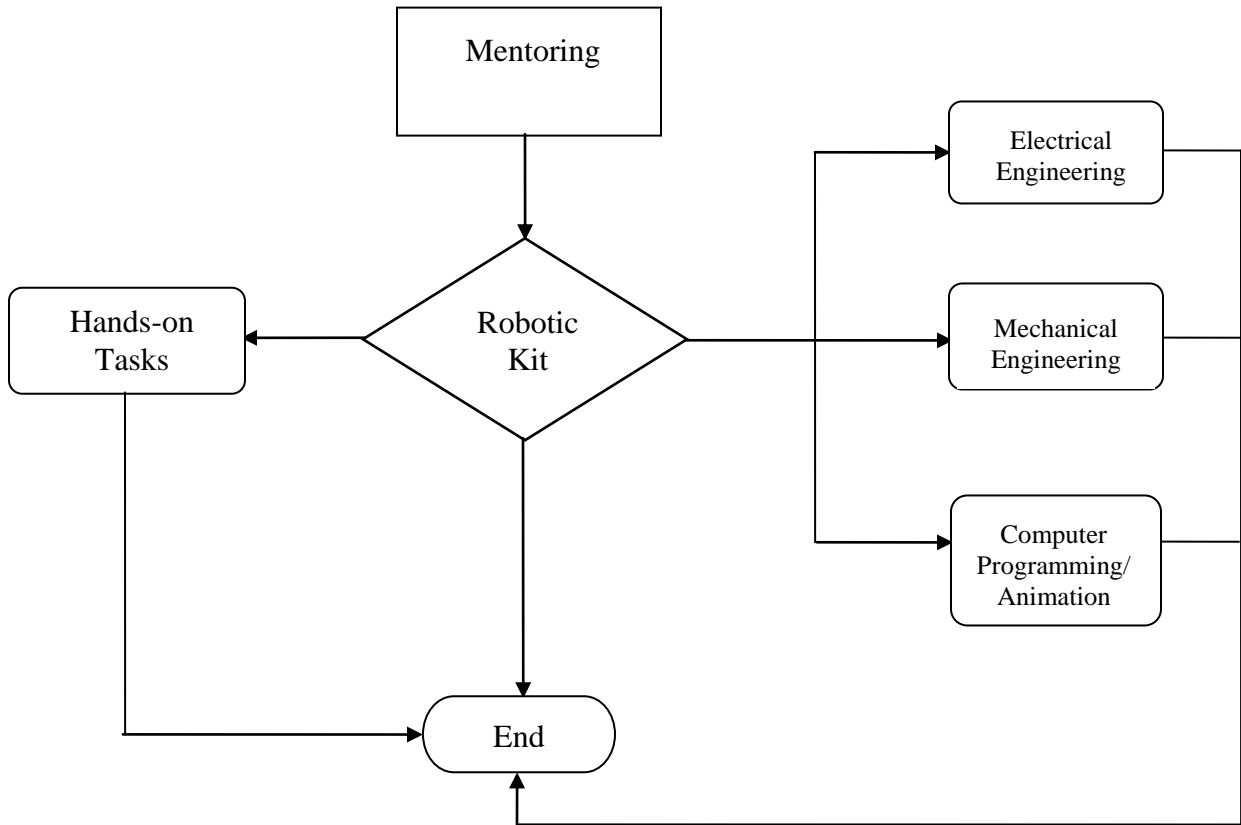
VI. Models for Outcome Demonstrations-are the various ways in which instructors can evaluate and observe student participants’ mastery of C-STEM curriculum:

1. Direct observation of student behavior.
2. Simulations.
3. Extended project.
4. Logs.
5. Student interviews.
6. Student presentations.

7. Videotapes.
8. Writing samples.
9. Group tasks.
10. Multimedia projects.
11. Possible global collaborations.

VII. Timeline: September-May

(A timeline is generated from the beginning to the end of school to set target dates for both the start and finish of a unit, project, and/or course. Project timelines are typically followed using the order illustrated below.)



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Appendix

Appendix A

Survey Instrument



1: Please rate the accuracy of information for the afterschool science, math, engineering, and technology (SMET) projects in the C-STEM program.

10=Excellent

[illegible]

10=Excellent

[illegible]

10=Excellent

1	2	3	4	5	6	7	8	9	10	Don't Know
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10=Excellent

1	2	3	4	5	6	7	8	9	10	Don't Know
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10=Excellent

1 2 3 4 5 6 7 8 9 10 Don't Know

10=Excellent

1 2 3 4 5 6 7 8 9 10 Don't Know

10=Excellent

1	2	3	4	5	6	7	8	9	10	Don't Know
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10=Excellent

1 2 3 4 5 6 7 8 9 10 Don't Know

Page 2 of 2

9: Please rate your performance level in science.
1=Poor 10=Excellent
1 2 3 4 5 6 7 8 9 10 Don't Know
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

10: What is your overall satisfaction of the C-STEM program?
1=Poor 10=Excellent
1 2 3 4 5 6 7 8 9 10
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

11: Please rate your performance level in technology?
1=Poor 10=Excellent
1 2 3 4 5 6 7 8 9 10
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

12: How does this program compare to your idea of after school programs you have participated in or heard about?
1=Poor 10=Excellent
1 2 3 4 5 6 7 8 9 10
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

13: How likely are you to continue in the C-STEM program?
1=Not Very Likely 10=Very Likely
1 2 3 4 5 6 7 8 9 10
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

14: How likely are you to pursue a science, math, technology, or engineering career?
1=Not Very Likely 10=Very Likely
1 2 3 4 5 6 7 8 9 10
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

15: How likely are you to continue to participate in SMET afterschool enrichment projects after middle school?
1=Not Very Likely 10=Very Likely
1 2 3 4 5 6 7 8 9 10
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

16: Select your grade level.
6th () 7th () 8th () 9th ()

17: Please select your age group:
10-12 () 13-14 () 15-16 ()

Please print your name and date below.

Name: _____ Date: _____

Thank you for your time in completing this survey. Your input is very valuable to us and will help us to create a better after school program for you.

Appendix B
Human Subjects Consent Form

Informed Consent Form
Research with Human Subjects

Dear Research Participant:

I am conducting a study of the C-STEM, Inc. after-school enrichment program as part of my Ph.D. program in Counselor Education with emphasis in Curriculum and Instruction at The Union Institute & University. Information about this research project will increase our understanding of what strategies will work to increase teacher participation in after-school enrichment programs and enhance student learning in engineering and will help in future developments of quality after-school enrichment programs for both teachers and students.

During this research study, you will be interviewed, asked to complete questionnaire(s), and observed. Your involvement will require about two hours of your time. After the research is completed, I will forward a summary of my findings and the implications of those findings to you by U.S. mail.

I am not aware of any risks involved in participation in this project. In fact, it should be an enjoyable experience for you. You will be identified by number and not by name. All responses will be confidential and your name will not be used in any report regarding this research. You are free to decline to participate or to withdraw at any time.

If you have any questions about this study, please contact me at (713) 443-4521 or via e-mail at RFlo993077@aol.com. Please leave a message if I am not immediately available.

Thank you in advance for your cooperation with this matter.

Sincerely,

Reagan Flowers

I, _____, consent to participate in the study of the C-STEM, Inc. after-school enrichment program conducted by Reagan Flowers. I understand that I may refuse to participate or withdraw from this study at any time. I understand that all responses will be confidential. I understand that I may direct questions about this project to Reagan Flowers.

Signature

Appendix C
Media Release/Consent Form

revised Sept 17, 2003

PERSONAL CONSENT FORM FOR PARTICIPATION IN
C-STEM, INC. SPONSORED COMPETITIONS

_____, my son/daughter/ward ("participant") has my permission to participate in all activities involved in preparing for, and participating in, all C-STEM, Inc sponsored competitions.

We, the undersigned adult and participant waive, relinquish and extinguish the disabilities of minority (if any). We release, discharge and agree to hold harmless Houston Independent School District and all elected and appointed officers, employees and agents (collectively HISD and C-STEM, Inc.), C-STEM Teacher Student and Student Support Services, West Briar Middle School, and all teachers and staff at those schools, as well as any volunteers involved (such as drivers, hosts, coaches, sponsors), and fellow participants involved in the competitions from any liability for any personal injury, death or property damage sustained by the participant arising out of his or her participation in the competition or preparations for competitions.

We understand that participants may work with and around power tools that involves some degree of risk.

We also understand that participants may travel in private automobiles, to and from competitions and as part of preparations for the competitions. These trips may extend out of Houston. We understand that some preparations may be conducted in private homes and that the above waiver includes the homeowners and hosts.

We authorize any of the teachers or volunteer coaches or hosts supervising the participants to act as our agent to consent to and obtain, at your sole cost and expense, emergency medical and/or surgical treatment or hospital care for the participant deemed advisable by the supervising teachers or volunteer coaches and/or emergency medical technicians, nurses, physicians and/or surgeons.

We grant permission to take photographs of and/or videotape the participant. These photographs may be used without further consent and without paying any compensation.

I, the undersigned adult, stipulate and warrant that I am the natural parent/natural guardian/legal guardian (strike phrases not applicable) of the participant.

I have read and understood this release on this ____ day of _____, 2003.

Participant (print)

Adult parent/ guardian (print)

Participant (signature)

Adult parent/ guardian (signature)

Phone numbers where we can be reached in emergencies.

Appendix D

C-STEM Application



C-STEM Teacher & Student Services, Inc.
3226 Alabama Street
Houston, Texas 77004

Office: 832-606-0261 Program Director: Reagan Flowers
E-mail: RFlowers1@cstem.com Program Advisor: Rena Faulkner
Web Site: www.cstem.com

Application for participation in the C-STEM, Inc. after-school enrichment program.

Name: _____ Male _____ Female
Last First

Birth date: _____ Age _____ School: _____

Address: _____

Parent/Guardian: _____ Grade: _____

Home Phone: _____ Cell Phone/pager: _____

Work Phone: _____ Employer: _____

Emergency Contact Information

Name: _____ Phone _____ Relationship: _____

Name: _____ Phone _____ Relationship: _____

Allergies: _____

Medications: _____

Any health conditions: _____

Transportation will be provided for some events for those students in the C-STEM after-school program.

- ☐ Yes, my child will be a part of the C-STEM after school program
- ☐ Yes, my child has permission to take transportation provided by C-STEM for activities
- ☐ Yes, my child has permission to attend all field trips/activities of the C-STEM program
- ☐ Yes, my child has permission to do supervised Internet activities and take pictures to be used by the program
- ☐ Yes, C-STEM may have access to my child grades and standardized test scores to be used for research to improve the program

Parent Signature: _____ Date: _____

*PLEASE SIGN AND RETURN THIS FORM TO THE PROGRAM ADVISOR. THANK YOU!



Teacher and Student Support Services, Inc.

C-STEM, INC. PARENT GROUP AGREEMENT FORM

District _____ School _____ School Year _____
Student _____ Name/Relationship _____

We the undersigned parents/guardians of C-STEM students want to be involved with and support our children in their pursuit to further their education in STEM fields.

This goal has prompted us to organize an active parent group. Members will elect officers and have regularly scheduled meetings to plan and organize support activities for C-STEM students. These activities may include but are not limited to:

- Car pools for C-STEM competitions and other related events
- Assisting in fundraisers
- Providing healthy snacks
- Newsletter Writing
- Advising students during their STEM activities
- Donating tools, building materials, etc.
- Chaperoning
- Assist with locating volunteers from industry
- Documenting student activities through photographs and video

Signature _____

Date _____



C-STEM Teacher & Student Services, Inc.
3226 Alabama Street
Houston, Texas 77004

PARENT SURVEY

We need your help! We want to make the C-STEM, Inc. after-school program more enriching for your child. Please tell us what you think we should do and when, and let us know what role, if any, you would like to play in C-STEM, Inc. program. Please return this survey to the Program Advisor. If you have any questions or concerns, do not hesitate to contact Rena Faulkner at 832-606-0261. Thank you for your time!

1. Do you think your child/children would benefit from participating in an academic after school enrichment program?
☐ Yes ☐ No
2. What type of activities do you think an after-school enrichment program should offer at your child/children school? (rank your top eight choices from 1-8, with 1 as your top choice)
☐ Community Service
☐ Computer Training
☐ Math & Science Bowl
☐ Homework help or tutoring
☐ Problem Solving Projects
☐ Field Trips
☐ Robotic Competitions
☐ Writing Competitions
☐ Design Competitions
☐ Other: _____
3. Would you be interested in being apart of an academic booster club to support the C-STEM, Inc. after-school program?
☐ Yes ☐ No

Appendix E Shell Proposal

A Proposal to Shell: An After-school Initiative to Attract Underrepresented Students to the Science, Technology, Engineering, and Mathematics Fields

Submitted by: C-STEM Teacher & Student Support Services, Inc.

Overview

C-STEM Teacher and Student Support Services, Inc. is a non-profit organization established in 2002 with the vision of reducing achievement gaps in science, technology, engineering, and mathematics (STEM) areas among underrepresented students in grades K-12. The goal is to encourage schools, families, and corporations to improve academic achievement and socio-emotional development of underrepresented students. Research indicates that minority students are not receiving an education that prepares or motivates them for careers in STEM-related industries.

For more than six years, C-STEM, Inc. founding director Reagan Flowers has worked with inner city and underrepresented youth enrolled in STEM enrichment programs and has experienced success. Her research and experiences indicate two factors that contribute to the lack of minority participation in STEM enrichment programs. The first issue is economics; every STEM enrichment program has an associated cost. High minority and economically disadvantaged schools do not typically have adequate funding to support a program, its staff, and related resources. A second factor is a lack of commitment from those involved. All STEM enrichment programs require an additional time commitment from teachers, without increased or additional compensation. Moreover, professional development training and support services to implement STEM enrichment are often inadequate. Due to current conditions, existing STEM enrichment programs are not available to underrepresented learning communities. The result is a negative effect on student achievement, both academically and socially. Students are unable to recognize the benefits of enrolling in higher-level math and science courses in early grades to ensure success after high school.

Local companies recognize the importance of C-STEM Inc.'s endeavors; many organizations across Houston benefit from an increased number of STEM-savvy applicants. Such applicants can have a particularly tangible effect on Shell. It is for this reason that C-STEM Teacher and Student Support Services, Inc. is requesting funding in the amount of \$60,000 from Shell to add C-STEM, Inc. after-school programs to three inner city middle and three inner city high schools in the Houston metropolitan area.

History

C-STEM, Inc. was created to provide teachers and participating schools with hands-on support services that allow maximal utilization of existing enrichment projects available to students in grades K-12 in both public and private institutions. Such support ensures

A Proposal to Shell: An After-school Initiative to Attract Underrepresented Students to the Science, Technology, Engineering, and Mathematics Fields

Submitted by: C-STEM Teacher & Student Support Services, Inc.

Overview

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Goals and Objectives

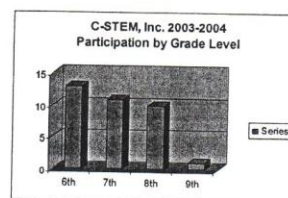
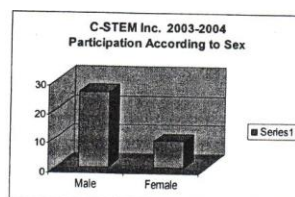
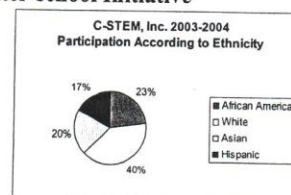
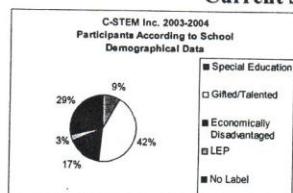
C-STEM, Inc. accomplishes organizational objectives by:

- Communicating and collaborating with college mathematics, science, engineering, technology, and education departments, non-profit organizations, and public, private, and charter schools.
- Engaging students in hands-on, competition-based learning activities that promote higher-order thinking and teamwork.
- Increasing students' awareness of the significance of STEM research throughout the world; multicultural contributions to STEM fields; and various career options via mentoring relationships with industry professionals, college students, and field trips.
- Increasing parent awareness of and involvement in student academic progress in STEM activities in an effort to strengthen family support of STEM education.
- Involving community groups, business/industry, research laboratories, museums, and educational/professional organizations in STEM activities through field trips and guest speakers.
- Empowering students by involving them in organizing, planning, and implementing STEM activities.

The goals of C-STEM, Inc.'s After-school Initiative are:

- Increasing underrepresented student participation in STEM enrichment programs.
- Strengthening STEM skills among underrepresented and minority students.
- Increasing post-secondary STEM discipline enrollment by minority and underrepresented students.
- Encouraging the pursuit of STEM careers among underrepresented students.

Current Status of the After-school Initiative



Implementation Methods and Use of Gift Funds

C-STEM, Inc. allows underrepresented students to participate in hands-on enrichment opportunities through project based learning primarily through robotics. Participating schools provide a safe environment where students can work on innovative C-STEM, Inc. projects. The ventures that C-STEM, Inc. assists schools with implementing include:

- NASA FIRST Robotic Competition
- SECME Mousetrap, Poster, & Essay Competition
- Odyssey of the Mind Competition
- GCTAME
- LEGO Robotics
- Simple Machines
- Bot Ball
- C-STEM, Inc. Community Low Rider Bicycle Project (TBA)
- C-STEM, Inc. Camp (TBA)
- C-STEM, Inc. Workshops (TBA)
- Grant writing services to schools
- Individualized projects and program development for schools
- Program/project evaluation

The purpose of student participation in the aforementioned STEM projects is to provide students with learning experiences that encourage them to think creatively and independently, learn to work successfully as a team, learn gracious professionalism, and become problem-solvers. STEM projects allow for improved student achievement, which assists schools in reducing achievement gaps in mathematics and science performance scores. The assignments are aligned with curriculum specific to participating schools, the TEKS (Texas Essential Knowledge and Skills). C-STEM, Inc. also offers support services that focus on improving schools and aid teachers in creating learning communities to reach students that are being left behind.

Acknowledgment for Participating Companies

Corporations that participate in the after-school initiative receive name recognition on school campuses in the following ways:

- Brochures, banners, and awards that carry the company name
- Internships and scholarships designated to targeted groups that are named in honor of the company
- Student recruitment literature that includes the company name
- C-STEM, Inc. will assist in establishing and/or improving the presence of a participating company on a school campus

2004 Supporters of the After-school Initiative

Annual Contributors

1. American Society of Mechanical Engineers (ASME) Petroleum Division
2. BTS

Sponsors

1. Alliance Engineering
2. Halliburton
3. WoodGroup
4. ConocoPhillips

Key Facts About Students Participating in After-school Initiatives

- Reasons given by students who join the after-school STEM enrichment program include the desire to learn about technology, the various opportunities to qualify for scholarships and internships, to challenge one's self, and, simply, to have fun.
- 2 out of 3 students that have participated in STEM programs want to return to the program as a mentor after graduation.
- 3 out of 4 students rate their relationship with the program sponsor as good.
- 1 out of 2 indicates the likelihood of pursuing STEM careers at the post-secondary level.
- In robotics competitions, approximately 26% of the participants are female, 31% a racial or ethnic minority, and 20% are underrepresented minorities.
- 19% of female students that participate in robotic competitions major in engineering as undergraduates; 16% of underrepresented minorities major in engineering in undergraduates.

Key Benefits for Students Participating in After-school Initiative

- Exposure to practical applications of math, reading, writing, and science, which lead to improved scores on the TAKS test.
- Improved student attendance at school.
- Improved student conduct and self-discipline.
- Improved problem-solving skills.
- Improved attitudes toward teamwork.
- Improved attitudes concerning the working world.
- Improved student achievement and increased self-esteem.
- Encourages students to develop good citizenship and study skills.
- Provides students with new experiences and creates a "STEM pipeline," which allows students to network within the industry and make connections prior to beginning their careers.
- Provides a safe, supervised place for students to learn and socialize away from negative community influences.

- Trains teachers, volunteers, mentors, and parents in the best STEM enrichment activities available.

Measurements of Student Data and Success in the After-school Initiative

- Pre and post activity surveys
- Report cards
- Standardized test scores
- Interviews/focus groups with students, parents, teachers, school administrators, and business partners
- Completion of STEM projects
- Participation in STEM competitions

Awards Won by Students Participants of the After-school Initiative

- NASA For Inspiration in Science and Technology (FIRST) Featherweight Award
- NASA FIRST Judges Award
- NASA FIRST Rookie-All-Star Award
- Space City Boosting Engineering in Science and Technology BEST Award
- SECME Mousetrap Car, Poster, & Essay Competition, along with a bottle rocket competition

Appendix – A

The Challenge

Research shows that minority* students have a negative image of higher-level math and science studies. These negative perceptions prevent them from pursuing fields of study that require such classes for success. C-STEM, Inc. proposes to work with students and expose them to real world situations through STEM competitions that allow them to use math and science in fun and exciting ways. C-STEM, Inc. will provide incentive-based scholarships and internships to students who enroll in higher-level math and science courses. C-STEM, Inc. will also provide students with support services to be successful in higher-level math and science courses; the result will be a plethora of young engineering students entering petroleum and petroleum related industries.

**minority – African-American, Hispanic, and females students*

A. Proposed Tasks

1.1 Scholarships for Students who have participated in STEM enrichment from grades 6-12

C-STEM, Inc. has an annual scholarship and internship budget of \$1,000. With the additional \$100,000 we expect to receive as a result of the proposed after-school initiative, the total scholarship and internship pool is expected to grow to \$10,000. The organization hopes to add another \$10,000 to this figure during the 2004-2005 academic year. This will raise the scholarship pool to approximately \$20,000 per year, allowing approximately 20 past participants of STEM enrichment programs to benefit from C-STEM, Inc. sponsored scholarships and internships.

1.2 Infrastructure Improvements

To increase student numbers C-STEM, Inc. will partner with additional schools in the Houston metropolitan area, including public, private, and charter schools. C-STEM, Inc. will also attempt to reach students who are home schooled. Additional grants will be submitted to fund and develop the C-STEM, Inc. After-school Initiative.

1.3 C-STEM, Inc. Program Guide

The delivery and implementation model of C-STEM, Inc. in grades 7-12 has several components:

- C-STEM, Inc. team planning
- Cooperative teaching and learning
- Interdisciplinary instruction
- Networking skills
- Study groups

- Test taking and study skills
- Goal setting and time management
- Reinforcement of basic skills
- Development of thinking skills
- Career exploration
- Role models and mentors
- Parental involvement
- Leadership development
- Community service
- Scholarship information & application
- University exploration and selection
- Evaluation of the program
- Data collection and reporting

In addition to these common components, there are eleven groups of participants in the C-STEM, Inc. program.

- C-STEM, Inc. office
- C-STEM, Inc. partners
- Local business and industry
- Community
- Parents
- School administrators
- School counselors
- Classroom teachers
- Media
- K-12 schools
- Students

At participating schools, a C-STEM, Inc. staff member assists a leadership team in planning and executing enrichment programs in science, technology, engineering, and mathematics. A typical leadership team includes the principal, a counselor, a science teacher, a math teacher, a technologist, and a language arts teacher. Other faculty is encouraged to support the leadership team and the student participants. The team roles can be described as follows:

- C-STEM, Inc. program advisor – supports leadership team, provides resources, acts as a facilitator, motivator and a contact person between C-STEM, Inc. partners
- Principal – lends support, secures additional resources, and acts as a motivator
- Leadership team – includes coaches, motivators, student mentors and recruiters

Leadership team members participate in educator leadership development provided by supporting partners of C-STEM, Inc. and other enrichment programs supported by C-STEM, Inc. The leadership team obtains:

- Details on implementing C-STEM, Inc. enrichment activities in their schools
- Resources on specific curriculum to support enrichment activities
- Methods on preparation and implementation of enrichment activities
- Information on C-STEM, Inc. opportunities for students at participating schools

C-STEM, Inc.'s efforts to develop effective programs and resources include:

- a middle school component
- a high school component
- local workshops
- scholarships
- internships
- access to available resources
- on-site support from C-STEM, Inc. staff

C-STEM, Inc. School Leadership Team Building

The building of a leadership team is the core to having successful C-STEM, Inc. enrichment programs in schools.

- I. Importance
 - A. To assure successful implementation of C-STEM, Inc. enrichment activities
 1. Set goals and objectives
 2. Plan and implement activities
 - B. Provide resources, support, and encouragement
 - C. Receive the full benefit of C-STEM, Inc.
- II. Building the team
 - A. Start with existing team and build
 - B. Secure the support of C-STEM, Inc. program from school administrators
 - C. Present C-STEM, Inc. enrichment opportunities to entire staff and student body
- III. Leadership team members
 - A. C-STEM, Inc. program advisor
 - B. Principal
 - C. School staff
 - D. Parents
 - E. Students

General Program Processes

- Students will improve scores in science, mathematics, reading, and writing on standardized tests.
- Students will participate in C-STEM, Inc. enrichment activities and competitions to improve skills.
- Students will take field trips to gain exposure to universities/colleges, technological industries, and institutions that encourage career development in STEM areas
- C-STEM, Inc. program advisor reviews all available data.
- C-STEM, Inc. will collaborate with community organizations to sponsor science, technology, engineering and mathematics career information sessions
- C-STEM, Inc. program advisor will recruit parents to serve as information resources
- C-STEM, Inc. will organize and plan meetings and distribute information
- C-STEM, Inc. program advisor will provide scholarship and internship information to students regarding science, technology, engineering, and mathematics.

Recruitment activities

- Teachers will provide information to students to motivate interest
- Parent and community involvement will be solicited and utilized
- Additional school-based programs will be utilized
- Successful past participants will be used as role models

Maintenance Activities

- Use registrar and counselors
- Daily, weekly, and annual student progress reports
- Academic awards at the end of school term
- Provide incentives for students improvement and success
- Ensure that qualified students are prepared to take ACT/SAT
- Provide access to peer and outside tutoring

C-STEM, Inc. Program Chart

WHO	WHAT	HOW
C-STEM, Inc.	Workshops, training, resources, motivator, morale builder, facilitate enrichment activities, program assessment, coordinate program, establish support group, guidelines, provide support services	Organize in-services, set policy and procedures, program implementation, awards, funding locator, consultants, public relations, resource materials, leadership training, participation in enrichment activities, plan activities, cooperative teaching/learning
Teacher	Team planning, team member, student support, facilitator, resource person, staff development	Work cooperatively, share knowledge and skills, networking, encourage participation, advise, tutor, coach, mentor, provide learning opportunities
Middle schools	Career awareness, team member, link with elementary schools, programs, tutors	7 th – 8 th grade outreach, cooperative STEM enrichment activities
High schools	Career information, link with middle schools, provide resources, tutors, mentors, link with colleges, team member	9 th – 12 th grade, share materials, peer groups, advisors for middle schools, campus tours, job shadowing, research/interviews, networking opportunities for students and teachers, interdisciplinary student learning
Students	Active participants, peer support	Engage in C-STEM, Inc. learning activities, tutor/mentor
Community	Support C-STEM, Inc. program, reward and acknowledge student achievement, sponsor C-STEM, Inc. activities, provide resources, volunteers, career awareness	Mentor, tutor, awards and rewards

1.4 Costs to Participating Companies

C-STEM, Inc. after-school programs are an investment in STEM education that will greatly benefit engineering, petroleum, energy and related industries. C-STEM, Inc. is requesting \$60,000 per year over a five-year period. 90% of these funds will benefit six after-school programs. The remaining 10% will be utilized to establish initiatives to perpetuate existing STEM enrichment programs after the end of the five-year period.

1.5 Curriculum Plan

The C-STEM, Inc. program provides organizations with a direct avenue to a diverse audience and an opportunity to encourage the participation in STEM courses. C-STEM, Inc. uses a range of technologies and promotes exploration and discovery using interactive adventures. C-STEM Inc.'s innovative approach to math, science, and technology encourages higher order thinking that allow students to apply skills that are being taught each day.

Learning activities encompass:

- Hands-on construction of models
- Brain teasers
- Observation activities
- Logic exercises
- Data sorting and analysis activities

Curriculum and software used for instructional purposes with elementary and middle school students include the *Discovery Channel School*, which includes interactive CD-ROMs; *A World in Motion* by the SAE Foundation for Science and Technology Education; NASA FIRST Robotics; Space City BEST Robotics; GCTAME; Bot Ball; and Simple Machines. Applications using Intel Software are forthcoming.

Goal Setting

Students are introduced to C-STEM, Inc. projects. They review and discuss what is requested of them, and share ideas about how to go about solving the problem. Students work in teams and record their work in design logs.

Knowledge Building

Many activities are included in this phase to develop the knowledge and skills students need to design solutions to problems. Students build models and determine function. Through hands-on activities, teams construct models, record observations, and discuss results with peers. They move from simple explorations and opinions to controlled experiments and performance predictions based on graphs, diagrams, and results tables.

Design

Student teams design their models to project specifications. They determine the values of variables, plan construction, and predict performance based on knowledge from previous activities.

Building and Testing

Students build their design and test it to determine if it meets performance criteria.

Presentation

Student teams make presentations of their work to an audience.

