CLOSING THE RACE AND GENDER GAPS IN COMPUTER SCIENCE EDUCATION

By

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ABSTRACT

Closing the Gender and Race Gaps in Computer Science Education

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Life in a technological society brings new paradigms and pressures to bear on education. These pressures are magnified for underrepresented students and must be addressed if they are to play a vital part in society. Educational pipelines need to be established to provide at risk students with the means and opportunity to succeed in science, technology, engineering, and mathematics (STEM) majors. STEM educational pipelines are programs consisting of components that seek to facilitate students' completion of a college degree by providing access to higher education, intervention, mentoring, support infrastructure, and programs that encourage academic success. Successes in the STEM professions mean that more educators, scientist, engineers, and researchers will be available to add diversity to the professions and to provide role models for future generations. The issues that the educational pipelines must address are improving at risk groups' perceptions and awareness of the math, science, and engineering professions. Additionally, the educational pipelines must provide intervention in math preparation, overcome gender and race socialization, and provide mentors and counseling to help students achieve better self perceptions and provide positive role models.

This study was designed to explorer the underrepresentation of minorities and women in the computer science major at Rowan University through a multilayered action

research methodology. The purpose of this research study was to define and understand the needs of underrepresented students in computer science, to examine current policies and enrollment data for Rowan University, to develop a historical profile of the Computer Science program from the standpoint of ethnicity and gender enrollment to ascertain trends in students' choice of computer science as a major, and an attempt to determine if raising awareness about computer science for incoming freshmen, and providing an alternate route into the computer science major will entice more women and minorities to pursue a degree in computer science at Rowan University. Finally, this study examined my espoused leadership theories and my leadership theories in use through reflective practices as I progressed through the cycles of this project.

The outcomes of this study indicated a large downward trend in women enrollment in computer science and a relatively flat trend in minority enrollment. The enrollment data at Rowan University was found to follow a nationwide trend for underrepresented students' enrollment in STEM majors. The study also indicated that students' mental models are based upon their race and gender socialization and their understanding of the world and society. The mental models were shown to play a large role in the students' choice of major. Finally, a computer science pipeline was designed and piloted as part of this study in an attempt to entice more students into the major and facilitate their success. Additionally, the mental models of the participants were challenged through interactions to make them aware of what possibilities are available with a degree in computer science. The entire study was wrapped in my leadership, which was practiced and studied over the course of this work.

DEDICATION

I dedicate this work to my wife and best friend Rosemary. It has been a long journey and you supported me, believed in me, and were patient with me through it all. To my children, John and Sondria, thank you for appreciating all of the hard work and sacrifices I have made to give you a chance to be successful. Finally, to my mother Delores Robinson, your love, strength, and inspiration instilled in me all the basics I needed to make my journey through life and the desire to be the best that I can be.

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We want the facts to fit the preconceptions. When they don't, it is easier to ignore the facts than to change the preconceptions - Jessamyn West

Defining the Educational Gaps for Female and Minority Students

Introduction

America was founded by immigrants from England seeking freedom from religious persecution and censorship. The democracy that was established by the founders of America offered the freedom to pursue personal goals, practice religious beliefs without fear of persecution, and freely express thoughts and ideas without fear of censorship. These freedoms led to a democratic political structure marked by a high degree of individualism, civil liberty, and a government limited by law. America has seen the immigration of many groups of people seeking the freedom that the country offered. As a result, America's population became a melting pot of people from different ethnic, social, and political backgrounds.

One of the main ideals that America offered to all of its citizens was equality. This equality applies to all aspects of life in America, be it social, economic, or educational equality; all of America's citizens have the right to equally share the opportunities available in America. In a perfect society, this ideal would work for all, but America is far from ideal. Prejudice, greed, and racism have allowed the formation of a class based society within our democracy in which all is not equal. We have made great strides as a country over the last few centuries in making the ideal of equality a reality. Affirmative action has helped minorities and women receive better employment opportunities and somewhat equal pay. School integration has enabled minorities to attend better schools and provided better educational opportunities. Additionally, minorities and women have seen an increase in their political and economic power, but there are still many obstacles to surmount. As America continues to become more racially and ethnically diverse, there is a need for policies and programs that address the inequalities present in our society that impede on the rights of a group based on their racial, gender, economic, or social background (Chemerinsky, 1983; Joseph, 1980; Katz, 1988; Smith, 1925; Verba & Orren, 1985).

One area that still reflects the inequities that exist in America is education. To date, there are a limited number of underrepresented students in math, science, and engineering majors in our higher education institutions (Sax, 1994a, b, c; Sax, 1996; Smith & Lusthaus, 1995; Williams, 1960). The underrepresented student population is comprised of minorities, students from poor socioeconomic backgrounds, and women. Math, science, and engineering education needs to be presented in a sociocultural context for underrepresented students in order to overcome social, racial, gender, economic, and cultural issues facing this population of students in America.

Lev S. Vygotsky (1978) presented the idea of a link between social and cultural processes in a society and how these are linked to the construction of knowledge. Education presented in a sociocultural framework allows students to construct meaningful knowledge by presenting ideas in a context that relates to their gender, social, economic, and cultural life experiences. This means that learning for the individuals in a society is directly impacted if information is presented in a way that takes into account race, gender, economic, and cultural socialization (Gindis, 1999). Educational paradigms in a society must therefore evolve as a society evolves and socialization of its citizens evolves. Society today is driven by technology and new educational paradigms must be developed and presented in a sociocultural context.

Life in a technological society brings new paradigms and pressures to bear on education. These pressures are magnified for underrepresented groups and must be addressed if they are to play a part in society. Pipelines need to be established to provide underrepresented students with the means and opportunity to succeed in mathematics, science, and engineering. Success in these professions means that more educators, scientists, engineers, and researchers will be available to add diversity to the professions and to provide role models for future generations. The issues that the pipelines must address are improving underrepresented groups' perceptions of the math, science, and engineering professions. Additionally, the pipelines must provide intervention in math preparation, overcome gender and race socialization, and provide mentors and counseling to help students achieve better self perceptions and provide positive role models.

Life in a technological society also means that students must be technologically literate. Literacy in technology needs to be defined in a sociocultural context that allows underrepresented groups to construct knowledge and develop the skills to cope with life in a technological society. New educational paradigms should incorporate the study of technology in the context of critical thinking, experiential and cooperative learning, and accommodation of learning styles. Additionally, new educational paradigms should also incorporate theoretical and practical learning, abstract and applied knowledge, interdisciplinary approaches, integration of academic and vocational education, multicultural awareness, ethics, responsibility, and values. Literacy in technology, in this framework, is an important component of education that aims to prepare students for life and for work in a technological society (Sandra, 1994).

Rationale for the Study

In preparing students for life and work in a technological society, the following issues must be addressed in an effort to provide equal access to underrepresented students. The idea that math, science, and engineering are white male dominated disciplines must be redefined to include women and minorities. New paradigms should include and embrace cultural differences and learning styles, ethics and values, the impact of technology, and educators must strive to change stereotypical threats such as poor preparation, limited access to resources, gender and race socialization, lack of confidence, and a lack of women and minority mentors (Beyer, Rynes, Chaves, Hay & Perrault, 2002; Cardinale, 1992).

Technology literacy requires that students are introduced to science, math, and engineering in a way that allows them to develop the analytical skills needed to become lifelong learners, and that information is presented in a sociocultural context that allows underrepresented students to construct a meaningful learning environment (Frierson, 1981; Griffin, 1990; Hawkins & Paris, 1997, Jungck, 1990). One way in which this could be done is through early intervention. Early intervention has been shown to improve the success and retention rates for underrepresented students pursuing a college education (Perna & Swail, 2001; Perna, 2003). Summer bridge programs are a typical means of intervention that many colleges and universities use to address stereotypical threats.

One area of focus for summer bridge programs is on academic preparation and performance of minority, female, and low-income students. To address these issues, many initiatives have been instituted by government and educational institutions (Blake, 1998). Outreach programs to improve student performance, starting at the K-12 levels, and bridge programs to improve the enrollment, success, and retention of minority and low income students in higher education institutions are two examples of programs implemented by many colleges across the nation (Garcia, 1991; Laguardia, 1998; McElroy & Armesto, 1998). In addition to programs geared toward disadvantaged students, female students have been the focus of research and programs that examine ways to entice more women into math, the sciences, and engineering (Cardinale, 1992; Durndell, Siann & Glissov, 1990; Kramer & Lehman, 1990; Mattingly & Tobias, 1999; Sax, 1994; Schubert, 1986; Thomas, 1980).

The disparity of disadvantaged students and women in mathematics, science, and engineering majors leads to shortages of these groups in industry, education, and research occupations. In order to address this dilemma, a pipeline must be established that provides opportunities for these underrepresented groups ("Minority Participation in R&D", 1981; "Blacks Increasingly Are Moving into the Business Ph.D. Pipeline", 1996). One possible solution is early intervention in the form of a summer bridge program that seeks to address the needs of underrepresented groups and the reasons they tend to shy away from pursuing a degree in science, engineering, or mathematics. There are currently programs in place that address the unpreparedness of students to deal with the rigors of college life, but these need to be expanded to address factors that drive underrepresented students from math, the sciences, and engineering, such as lack of math skills, gender and race socialization issues, lack of tutors and mentors, and education presented in a context that does not allow these students to construct meaningful learning environments (Croom, 1984; Griffin, 1990; Hill, 1990).

Many programs exist that are aimed toward minorities and females to encourage them to pursue math, science and engineering. The Urban Project at the City University of New York was designed to identify and provide minority high school students, who had underdeveloped potential in math and science, with educational interventions that would encourage them to pursue careers in these fields. The program was a multifaceted program that provided a bridge component to help the students adjust to college life and academics, field trips and seminars to expose the students to the academic training needed to succeed in math and science careers, and a summer institute where faculty from high schools and colleges could exchange ideas on curriculum and pedagogy that integrated science, math, computer science, and language arts (Croom, 1984). Similarly, The Detroit Area Pre-College Engineering Program, Inc. (DAPCEP) was designed to increase the number of Black, Hispanic, and Native American middle school and high school students who pursue careers in science, engineering, and other technical fields through instruction, motivational activities, and intervention (Hill, 1990). In addition to ensuring success in college for disadvantaged students, A Better Chance, Inc (ABC) sought to increase the number of ninth and tenth grade minority students in science and math careers through placement programs in preparatory and select public schools utilizing aggressive recruitment, selection, and retention of minorities (Griffin, 1990). These programs all sought to introduce at risk students to engineering, science, and math, but they are broad and seek to address issues of early exposure and preparation, but in a more narrow view, computer or technology literacy should also be a component to programs of this type.

The idea of computer literacy must also be examined through a sociocultural and ethnographic lens to ensure a continuum of minority and women educators and researchers. Frierson (1981) proposed a pipeline that would equip promising minority students with the skills to pursue careers in research and development. This is just one facet of the problem, moving disadvantaged students into the pipeline that would have the end goal of supplying researchers, as well as educators, and workers to fill the positions created because of the impact of technology on society ("Blacks Increasingly Are Moving into the Business Ph.D. Pipeline", 1996; Cross, 1994; "No Blacks in the Academic Pipeline? Oh Please!", 1997*)*. The number of disadvantaged students obtaining Ph.D.s needs to be increased through new and innovative programs at colleges and universities. One possible solution is for educational institutions to develop Ph. D. programs that entice and retain minorities without the concern of quotas (Mervis, 1998; Mervis, 1999). Additionally, the hiring practices in educational institutions need to place more minorities in positions of power and make jobs more attractive to minorities to provide diversity and role models and mentors to disadvantaged students (Konrad & Pfeffer, 1990). This would also address the issue of a shortage of minority faculty members in high ranking universities, in particular the field of computer science, where Blacks only makeup 0.9 percent of the faculty ("No Need for a Calculator to Tabulate Black Computer Science Faculty at the Nation's Highest-Ranked Universities", 1999).

Minorities and women face similar visibility issues in industry. Without a pipeline that produces educators, researchers, and workers, similar gaps will carry over into industry (Hinomoto, 1975; Meares & Sargent, 1999; Nelson, 1985). Industry demands a skilled workforce to meet the demands of a technological society. This workforce must be technologically literate, which places pressures on the educational system to develop programs to meet these needs. Minorities in particular are far less literate in technology than Whites and new educational paradigms must be developed to ensure minorities are placed on a level playing field with the majority in a technological society (Hawkins & Paris, 1997; Slater, 1994).

The success of minorities and women in the future depends upon their technological or computer literacy. Computer literacy needs to be viewed in a sociocultural context, where the end goal would be to empower all students with the needed skills and the capacity for learning to survive life and be productive members in a technological society. This is essential for underrepresented students if they are to assume future roles as educators, researchers, and workers in a technological society. This sociocultural model of computer literacy takes into account how students learn about computers, how they construct their knowledge of computers, and how it differs for different cultures. Computer literacy must be taught in a context that allows students to incorporate their life experiences and cultural knowledge into the construction of their knowledge (Jungck, 1990). Educators must also embrace new paradigms that incorporate a sociocultural framework. Educators must look at traditional computer literacy education through a critical eye to ensure that conditions are conducive for underrepresented students to construct meaningful learning environments. Traditional pedagogy and curriculum fails, in many instances, to keep pace with the pressures on education caused by technology.

The ideal of computer literacy may not take into account what is needed for computer literacy in the real world. In addition to knowing how to use computers, students must understand more of the underlying concepts in order to develop the skills necessary to overcome inequities in computer knowledge. Typically, White students have access to more computers and knowledge than do their minority counterparts, and the cultural experiences of minorities are also less conducive to developing a meaningful construction of computer knowledge (Hawkins & Paris, 1997). Educators in a technological society must be aware of these issues and foster the development of computer literacy skills in a sociocultural context (Evans & Elium, 1982; Forsythe, 1968; Goodson & Mangan, 1996; Hanley, Terpstra, Gillaspy & McCoy, 1983; Knuth, 1974; Lockheed & Mandinach, 1986; Orchard, 1975; Ruthven, 1984; Wyatt, 1985).

The pressures that technology has placed on society and education presents many obstacles for underrepresented students to overcome. There is a need to clearly define the obstacles faced by underrepresented students and to explore new educational paradigms that attempt to address these issues. This study was designed to explorer the underrepresentation of minorities and women in the computer science major at Rowan university through a multilayered action research methodology. The purpose of this research study was to define and understand the needs of underrepresented students in computer science, to examine current policies and enrollment data for Rowan University, to develop a historical profile of the Computer Science program from the standpoint of ethnicity and gender enrollment to ascertain trends in students' choice of computer science as a major, and an attempt to determine if raising awareness about computer science for incoming freshmen, and providing an alternate route into the computer science major will entice more women and minorities to pursue a degree in computer science at Rowan University. Finally, this study examined my espoused leadership theories and my leadership theories in use through reflective practices as I progressed through the cycles of this project.

The enrollment data and policies were gathered and analyzed to form a breakdown, by ethnicity and gender, of students enrolled in Rowan University, with particular attention to the students who chose computer science as their major. Through the examination of enrollment data, a historical profile of the Computer Science program from the standpoint of ethnicity and gender enrollment was developed to ascertain trends in students' choice of computer science as a major. This study also attempted to raise the awareness of incoming freshmen in the Pre College Institute (PCI) about computer science and offered an alternative route into the major hoping that this would entice more women and minorities to pursue a degree in computer science at Rowan University and to create a continuum of underrepresented graduates able to fill the roles of educators, researchers, workers, role models, and mentors for future generations. This study represents an attempt to close the racial and gender gaps in computer science present in our society. The final phase of this study was to examine my leadership. I explored my leadership from the perspective of how it serves as the basis for this change project, how it was utilized during the project, and how it has evolved, and what I have learned as I progressed through the cycles of this study.

Research Questions

Rowan University is a higher education institution that has implemented a summer bridge program to address the issue of underrepresented minorities and retention rates. Rowan University's PCI is comprised of two components, the Educational Opportunity Fund (EOF) for students from low income families and Maximizing Academic Potential (MAP) for students who failed to meet the minimum entrance requirements, but show academic potential. Incoming EOF/MAP students attend an intensive five-week PCI session held on campus from July to mid-August. The institute takes a disciplined approach to teaching the survival skills necessary to succeed in college, and the participants have the opportunity to earn college credits during the summer institute. Students participate in course work, structured study periods, group discussions, and other activities that promote academic and personal success. At the end of the Institute, EOF/MAP staff evaluates all student performance records then recommends admission or denial of admission to Rowan University.

This study involved interacting with incoming freshmen in the PCI Program at Rowan University in an effort to raise awareness and entice more minorities and women into the field of computer science. The interaction was structured to introduce students to the concepts of computer science in an attempt to encourage them to pursue a computer science degree at Rowan University and empower them to survive life and become productive members in a technological society.

This study attempted to answer the following questions:

1. How can my leadership improve interest/enrollment in computer science education at Rowan University for underrepresented students?

2. What factors influence and hinder underrepresented students' choice of computer science as a major?

3. Can raising awareness about computer science and providing an alternate path into computer science have an impact on underrepresented students' choice of computer science as their major?

Significance of the Study

The significance of this study was to determine if more underrepresented students will choose computer science as their major. This is significant for underrepresented students because they will now be empowered to become future educators, researchers, and workers and to provide mentors and role models for future generations.

The students who attend the PCI at Rowan University represent an untapped resource for the Computer Science Department at Rowan University in terms of enrollment. Historically, the majority of the students in the program are students who would normally not have the opportunity to attend college due to economic issues or academic performance that is slightly below the entrance requirements at Rowan University. This body of students also has a high percentage of minorities and women. This does not mean these students are unprepared to handle the rigors of college; the PCI program is there to lend a "helping hand" to the students in the form of acclimating them to the college environment. This study therefore seeks to tap into this pool of students and entice more of this underrepresented population into computer science at Rowan University.

Chapter 2

Espoused Theory of Leadership

Introduction

> We live in a constantly changing world. Technological advances double every couple of years. With these advances come hard choices that may challenge existing moral standards. Our values are understood in the context of the life we live and the decisions of individuals and of society around us. We cannot separate our values from our experiences. However, these values must be open to change as we face new situations that call for evaluations of new courses of action. (http://www.woodrow.org/teachers/bi/1992/dilemmas.html).

Society places great emphasis on knowledge and practical skills, excluding the character of the individual. I am an educator and it is easy to get caught up in teaching knowledge without teaching about character. Schools are moral institutions, designed to promote social norms or ethics, and educators are moral agents or ethical leaders who must be committed to teaching these social norms, ethics, as well as knowledge. Ethics refer to standards of conduct that indicate how people ought to behave based on specific values and principles that define what is right and wrong. Ethics deals with the ability to distinguish right from wrong, and the commitment to do what is right. Individuals make choices based on their value systems and according to their own morality (Doyle, 1990; Eraut, 1994). As an educator, I must lead by example, use ethical decision making, choose to be ethical, and try to do the right thing.

What are the qualities of an ethical leader? It is my belief that an ethical leader must have a philosophical or theological basis from which he or she derives his or her understanding of ethics. Without this basis, one's practice of ethical behavior will be constantly changing as a result of changing circumstances and personal preferences. It can be likened to building a house on a reinforced foundation or building it on shifting sand. Those who do the hard work of building their ethical behavior upon philosophically or theologically derived moral absolutes are like the house built upon the reinforced foundation. Secondly, for a leader to be trustworthy, he or she must possess character, competence and commitment. Character is the combination of moral qualities by which a person is judged apart from intellect and talent. It is the alignment of one's speech and actions with one's core beliefs about reality, life and truth. More simply, character has to do with one's demonstration of virtue. Finally, trustworthy leaders must make strong commitments to their organizations, their constituents, their values and to the work of leadership. Without commitment, the character and competence of the leader remains disengaged. With commitment, the leader's character and competence are engaged in a specific place with a specific purpose to accomplish.

This is part of what I learned during my studies in the educational leadership program at Rowan University, the theoretical basis of why I do what I do. This has brought a deeper understanding of who I am as a person and who I am as a leader. The theoretical understanding of ethics can be likened to building a house on a sturdy foundation or building it on shifting sand. Those who base and understand their ethical behavior upon philosophically or theologically derived moral absolutes are like the house built upon the sturdy foundation.

Learning the theory behind ethics is just the first step. Ethics must be practiced and honed, so essentially we have espoused ethics and ethics in use or theoretical and applied ethics (Benjamin, 2001). Applied ethics is what we employ to solve ethical dilemmas and make compromise in the real world. The practice of our ethical beliefs should be governed by codes of ethical conduct and an ethical decision making framework. These codes of ethics allow us to keep a balance or allow interplay between our moral values and principles and our underlying assumptions. This allows us to make ethically sound decisions and compromises. This is extremely important for educators because we must use these codes to guide us in producing productive and well adjusted members of a democratic society. Additionally, an educator is responsible for guaranteeing equal educational opportunity for all. An educator's code of ethics allows him or her to practice and hone the responsibilities of teaching, the desire for the respect and confidence of one's colleagues, of students, of parents, and of the members of the community. These goals are obtained by following personal and professional codes of ethical conduct.

Theoretical Basis of My Leadership Theory

Rather than events that define my professional life, the analogy I believe is most appropriate for the development of my leadership is that of a leaf floating on a flowing river. At the head waters of a river it starts as a small trickle, a leaf falls from a tree and lands in the water; this is analogous to my birth, where my journey began. The river flows and gathers strength as water is added to it, cascading and rushing through some of its course taking the leaf along with it past, over, around, and sometimes crashing into obstacles, and as a mature body of water traversing its way through the countryside and into the future. The river is a life force, sustaining others; helping to shape its environment, and also being replenished itself (Bolman & Deal, 2001).

I began my journey by asking of what is my leadership comprised? My leadership is defined by three individual pieces that meld together to create my espoused leadership theory based upon who I am as an individual and how I utilize various leadership theories. I understand myself as an individual because I realize that my past and life experiences have molded the person I am today and am destined to become in the future. I understand who I am and why I lead as I do. My core beliefs and values determine how I chose to develop relationships, establish trust, and motivate those I seek to lead (Kouse & Posner, 2003). The last piece of my leadership is that I understand the leadership theories that I have been using throughout my career and I understand what effect each has on those I lead. I now understand myself and who I am as a leader from a personal perspective and the theories that I have been practicing. I now understand that I use the transactional leadership theory to motivate the individuals I lead. I use feminist leadership theory to develop and nurture relationships and build trust with those I lead, and I use the transformational/ethical and charismatic leadership theories to motivate, inspire, and achieve long-term success. I also understand the relationships between the individual theories that I subscribe to; I understand that transactional, transformational, and charismatic leadership are intertwined, that transactional, transformational/ethical, and charismatic leadership balance each other, and that none of the theories work without feminist leadership.

Transactional leadership is centered on a bartering system of rewards and punishment (Hoover, Petrosko, & Schulz, 1991). Goals are set and if the goals are met rewards are given, if the goals are not met, punishment is received. This works both on a material level and on a personal level. The transactional leader sets personal goals and the reward is self satisfaction for achieving those goals. This implies that a transactional leader recognizes what motivates individuals. The transactional leader seeks to satisfy the base or low-level needs. Humans have basic needs as outlined by Abraham Maslow (Ott & Shafritz, 2001), the four basic needs that humans have are well-being, safety, esteem, and self-actualization. Maslow went further to say that lower needs, well-being and safety, should be satisfied first; then the higher needs, esteem and self-actualization, can be satisfied. In a work environment, the transactional leader uses the system of rewards for work and performance as a motivator for those they lead. The transactional leader assumes that most individuals are motivated by the promise of rewards and uses this to push individuals to perform to a set of goals. This requires trust on the leader's part because, unlike Theory X leaders who assume that individuals are typically lazy, cannot be trusted, and must be constantly monitored and pushed, the transactional leader believes that individuals are driven by the same needs and goals that motivate the leader (Bolman & Deal, 2003) and that subordinates will strive to reach goals on their own accord. There are hidden dangers in transactional leadership; it can tend to be focused on the short term goals and may hamper long term innovations. Transactional leaders can have a tendency to concentrate on day to day details and goals instead of looking at the long term. This has the net effect of a loss of sight on the big picture and a concentration on short goals and rewards within the current procedures and processes that exist in an organization (Kuhnert & Lewis, 1987; Nisivoccia, 1997; Yammarino, Dubinsky, Comer, & Jolson, 1997). The transactional leader may also become preoccupied with personal goals, position and power, and rely too heavily on subordinates to keep things running efficiently. This has the net effect of clouding the goals and expectations and can lead to infighting and unproductive competition among subordinates as they strive to achieve their own personal wants and needs (Bolden, Gosling, Marturano, & Dennison, 2003). Another danger of transactional leadership is that practitioners of this theory see people as predictable. The main assumption is that people are motivated by material rewards only and hence their behavior is predictable. Give them rewards when they are good and they will continue to perform and punish them when they are bad and they will be motivated to do better. The flaw in this logic is that people are not predictable and do have higher needs that must be met. This is where transformational leadership helps transactional leadership cross that divide (Hoover, Petrosko, & Schulz, 1991).

The transformational/ethical leadership theory is very similar to the transactional leadership theory, but it goes one-step beyond transactional leadership. The transformational/ethical leader seeks to motivate by appealing to powerful moral values and ideals. The transformational/ethical leader has a number of ways to inspire people to higher levels; they serve as teacher, mentor, and coach. The transformational/ethical leader also uses different behavior styles to motivate people. Idealized influence is a behavior that makes people feel a powerful identification and strong emotions towards the leader, inspirational motivation promotes powerful symbols to arouse greater effort and feelings of belonging, individualized consideration provides coaching, support, and encouragement of specific followers and intellectual stimulation influences followers to view problems from a fresh perspective and with a new increased awareness. The transformational/ethical leader concentrates on the individuals' need for meaning and purpose by missions and strategies that benefit the group or the organization. The goals set by the transformational/ethical leader are more long term than those set by the transactional leader, but both understand the needs of the individual. The transformational/ethical leader is still concerned with goals and rewards but looks at this on a more global level. The transformational/ethical leader seeks to motivate the individual to reach longer-term goals by establishing group goals instead of individual goals. This involves setting a purpose for the group that is equitable for all the individuals within the group, it involves designing processes and procedures that will benefit the group as a whole and it involves releasing the potential within each individual, which in turn benefits the group (Bass, 1997; Bass & Steidlmier, 1998; Couto, 1997; Hickman, 1997; Hilosky & Watwood, 1997; Jantzi & Leithwood, 1995; Koh, Steers & Terborg, 1995; Leithwood & Jantzi, 1999; Liontos, 1992; Lunenburg, 2003; Mullin & Keedy, 1998; Pejza, 1994; Robles, 1998; Turan & Sny, 1996). This is similar to Theory Y leaders who seek to arrange the organization in a way that allows the individuals to achieve their goals by directing their efforts towards group rewards (Bolman & Deal, 2003). Transformational/ethical leadership also helps to build a sense of community because it focuses more on a shared group vision and system of beliefs. The individuals all work toward a common goal, which is the basis of a community (Bolden, Gosling, et. al, 2003). This is how transformational/ethical leadership balances or refocuses transactional leadership. The result of transformational/ethical leadership is empowering or transforming others to take more initiative in their work and building their self-confidence. The focus is not just on material rewards, but on role modeling and a definition for success.

The charismatic leader and the transformational/ethical leader can have many similarities, in that the transformational/ethical leader may well be charismatic. Their main difference is in their basic focus. Whereas the transformational/ethical leader has a basic focus of transforming the organization and, quite possibly, their followers, the charismatic leader may not want to change anything. Despite their charm and apparent concern, the charismatic leader may well be somewhat more concerned with themselves than anyone else. The values of the charismatic leader are highly significant. If they are well intentioned towards others, they can elevate and transform an entire organization. If they are selfish, they can create cults and effectively rape the minds of the followers. Their self-belief is so high, they can easily believe that they are infallible, and hence lead their followers into an abyss, even when they have received adequate warning from others. The self-belief can also lead them into psychotic narcissism, in which the leaders' self-absorption or need for admiration and worship can lead to their followers questioning their leadership. They may also be intolerant of challengers and their feelings that they cannot be replaced can mean that there are no successors when they leave (Conger & Kanungo, 1997; Howell, 1997; Oommen, 1967; Shamir, House, & Arthur, 1993). This inherent danger in charismatic leadership must be balanced, just as there is a balance in transactional/transformational/ethical leadership. The number one danger in charismatic leadership is the hero or God complex. The charismatic must put aside the many temptations of adoration by the masses and remain grounded and must not sink into a world of self love and self indulgence, but continue to care for the feelings and needs of others. Feminist leadership serves as a good balance to charismatic leadership because it keeps a charismatic leader grounded.

Both transactional and transformational/ethical leadership are focused on goals and rewards and seek to structure an organization in a framework that accommodates this model, (Doyle & Smith, 2001) but underneath lies the individuals and relationships between the individuals. Feminist leadership is concerned with the relationships. Relationships are the ties that bind the group together. These relationships must be nurtured and allowed to develop because they lead to interactions among the individuals that have a direct effect of group dynamics. Feminist leadership takes into account the differences in individuals based upon race, sex, background, and experiences. Relationships within a group are influenced by these differences and the interactions that take place are the invisible glue that binds the group together (Bartunek, Walsh, & Lacey, 2000; Cancian, 1992; Grogan, 2000; Hill-Davidson, 1987; Kezar, 2000; Ropers-Huilman, 1998). Outcomes are possible because of these relationships that would not be realized if the interactions are not allowed to take place. This means that hidden potential within the group may never be realized if interactions between the individuals are not allowed to take place (Wheatley, 1999). Dana Zohar (1990) explains that the "I" or "The Self" is formed based on quantum memories and relationships. Quantum theory states that quantum particles have no beginning and no end, so they continuously exist as a particle or a wave. Every particle that has ever existed still exists, and every particle that ever existed carries with it past and present possibilities or memories. What this implies is that we, as individuals, are shaped by our past and present to form the "I" or quantum self. The quantum self is created on two fronts, reincarnations of the past and recreation of the individual moment by moment. This implies that the quantum self or the "I" is a dynamic entity that evolves moment to moment, but is anchored to the past by quantum memories.

Relationships also shape the quantum "I". As quantum particles that exist as waves interact with other particles' waves a transition occurs which produce a reality, so as quantum beings we emit waves and interact with other quantum beings creating new possibilities and realities. This is the “I-Thou” relationship or the quantum “we”. This explains how intimate relationships function. Since quantum particles interact and can become as one, and since we are quantum beings comprised of quantum particles, in intimate relationships we can become as one or “we” with other quantum beings. With this understanding of Zohars’ quantum self, the next step is to explore how this relates to my leadership.

My leadership has evolved and will continue to evolve through interaction with others and as I continue to learn about myself and my leadership. I have come to realize that my personal and professional codes of ethics are the basis of my leadership. I have learned that I wish to get more underrepresented students to choose computer science as their major through my transformational/ethical leadership, adding more diversity to the math, science, and engineering disciplines. I also use transformational leadership in an ethical sense by seeking to improve the society in which I live by educating its citizens.

The theories that I have explored during my studies in the educational leadership program at Rowan University reflect the basis of my personal and professional ethical codes. The individual has the potential to be virtuous and just. Through education and practice one becomes virtuous and just. Aristotle described the idea of virtue in *Nicomachen Ethics* (as cited in Ciulla, 2003) as habits or skills that are learned and honed by practice. He believed that we are better off if we are happy and we achieve happiness through behaving ethically. Aristotle also believed that virtue must be taught and that we learn about virtue from role models and the society we live in. Plato explored justice in his work *Republic* (as cited in Ciulla, 2003) and he also stated that justice and virtue are characteristics obtained through education and sharpened through practice. As an educator, I seek to foster the ideals of justice and virtue by trying to act as a role model. I always seek to do what is fair for all students and I encourage tolerance and respect for each individual. This lends itself to the idea of respect, caring, and tolerance for others. This was also outlined in *The Parable of the Sadhu* (as cited in Ciulla, 2003), which illustrates the notion that we are our brothers' keeper, hence as educators we have the responsibility of teaching justice and virtue. Plato also viewed justice and virtue as an integral part of how one yields power. Justice and virtue temper power so that it is used for the good of all, for without justice and virtue, power would be used for the benefit of the individual.

Development of the individual is also important. We all have "Monsters of the id" (Forbidden Planet, 1956) or inner demons that tend to drive our actions unless tempered by justice and virtue. Johnson (2005) explored these demons and the affect that power can have, as did Hobbes, Yukl, Rand, and Machiavelli (Ciulla, 2003). The insecurities, fears, and desires of the individual can lead to unethical behavior when not controlled and coupled with power. A leader has the ability to shape the environment under his or her control through the power a leader yields. The ideals of justice and morality are shaped by the leader and if the leader's inner demons cause power to be used in an unethical manner or for personal wants, the followers will possibly see this as proper ethical behavior. As an educator, it is my ethical duty to ensure I keep the best interest of those I teach at the center of attention (Shapiro & Stevkovich, 2001).

Individuals are the building blocks for a society and ethics are the rules that govern how the individuals interact with each other. Individuals have personal ethics such as justice, caring, ideals of right and wrong, and virtue. Through relationships a group or shared set of ethics is developed, which serves as the basis for correct behavior in a society. These individual relationships are the important key in the development of a society. This is the essence of Kant's theory (Ciulla, 2003). Kant's theory states that the basis of a society is mutual respect for each individual in the society or the generation of good will, but this is not always what is in the best interest of a society. Following Kant's theory literally can lead to actions that are done for good will regardless of the consequences, as long as good will was the intent of the action. John Mills' Utilitarianism theory (Ciulla, 2003) goes one step beyond Kant's theory by ensuring that all actions are for the good of the group, or in this case, society. Mills' theory grounds action in morality instead of actions done for the right reason, regardless of the outcome. As educators, we are part of a society bound by the morality and ethics of the society, so it is our responsibility to ensure that the ideals of the society are taught to the individuals so that they have the understanding which provides the ability to integrate into the society in which they live. As an educator, it is imperative that I follow personal and professional codes of ethical conduct to ensure the ideals of equity, tolerance, caring, justice, and virtue are instilled in those I teach. This will ensure the individuals that I teach will have the knowledge to become well adjusted, successful citizens in the society in which they exist.

Amy Gutmann (1999) discusses ethics in education in the context of a democratic theory of education. Gutmann believes that all children of a democratic society should be educated, and that this is the primary responsibility of a democratic society. The principles provided by Gutmann's theory center on who has authority to make decisions about education, and what moral boundaries should be observed in the decision making process. Gutmann's theories are based on John Dewey's work, in which he states that "what the best and wisest parent wants for his own child, that must the community want for all its children" (Gutmann, 1999, p. 13). Gutmann questions whether this ideal should be the standard for all children. She believes that a democratic theory of education recognizes the importance of empowering citizens to make educational policy and also of constraining their choices among polices in accordance with those principles of nonrepression and nondiscrimination that preserve the intellectual and social foundations of democratic deliberations (Gutmann, 1999).

Gutmann's (1999) discussion on the purpose of higher education and the distribution of higher education was of interest to me since I work in higher education. Gutmann argues that universities serve an essential democratic purpose by preserving the tension between social standards and practices by helping citizens contain professional authority within its proper realm. They can serve that purpose only if they do not take their cues from the market in an effort to maximize social utility. On the other hand, the autonomy of universities is relative to their democratic purposes. Universities serve as gatekeepers to many social offices; they have a Rowan monopoly on the education necessary for many of the most valued jobs in our society. Underrepresented students must be provided with the tools, through education, to obtain the benefits available in the society we live (Gutmann, 1999).

Theoretical Basis for Change through Sociocultural Education

As an educator, I want to instill in those I teach the knowledge to make decisions that take into account the individual, the underlying values, and the group. Chris Argyris (2001) presented the idea of single loop and double loop learning and how these impact the decisions one makes based upon their underlying assumptions. In essence, the theory states that the underlying assumptions and values must be examined to avoid being locked into a loop in which one is destined to repeat the same mistakes over and over, Argyris called this single loop thinking. This will lead to the same decisions or mistakes being made repeatedly unless the basis of the decision is examined. When the underlying assumptions are examined, the single loop cycle can be broken and a new understanding is obtained; Argyris (2001) termed this double loop thinking. Based upon Argyris' work, educational paradigms must be periodically evaluated to ensure that the underlying assumptions on which they were based reflect changes in society. Technology has brought many new pressures to bear on society; our lives are intertwined with technology. Organizations have become virtual, education has become virtual, the workforce is more technologically savvy, research has a different focus, and students are more sophisticated. The evolution of these integral parts of a society has caused society itself to evolve. Based upon these ideas, education must also evolve to produce individuals capable of fulfilling roles in the workforce, research, and education. The underlying basis for education is to produce productive citizens, but the rules have changed. We now live in a society filled with diversity, and there is a need for new educational paradigms that take into account the sociocultural needs of many diverse groups.

The framework I developed for my role as an educator is a philosophy that attempts to frame education in a sociocultural context. I follow personal and professional codes of ethics that serve as the basis for my educational philosophy and through these codes I attempt to address inequities present in our educational systems. Specifically, I attempt to provide all students, including underrepresented groups, with the tools needed to survive life in a technological society. Additionally, I employ reflective practice to ensure that my leadership is not operating in a single loop. Reflection allows me to study and assess my underlying assumptions, based upon my personal and professional ethical codes, to ensure my educational philosophy evolves as the society I live in evolves.

I am the person I am and my beliefs are what they are because of my life experiences, my morals and values, gender socialization, race socialization, and my education. These all play a part in knowing who I am and in the formation of my codes of ethics. Dana Zohar (1990) described this as the Bose-Einstein Condensate. In essence, this theory states that because we are made up of quantum particles and these particles interact with each other and display some level of consciousness, a state of resonance is achieved and all of the particles behave as one or form a consciousness.

On the quantum level particles seem to exhibit some level of consciousness. Zohar (1990) expands upon this to explain how this applies to the human brain. What the author extrapolates is that since there appears to be some form of consciousness in quantum particles and as the particles interact and relate to one another, they will eventually move from a wave form to a common particle form. This is called the Bose-Einstein Condensate. Zohar (1990) describes this as the individual parts behaving as a whole and hence becoming a whole entity.

> The crucial distinguishing feature of Bose-Einstein condensates is that many parts that go to make up an ordered system not only behave as a whole, they become whole; their identities merge or overlap in such a way that they lose their individuality entirely (Zohar, 1990, p. 83).

Zohar (1990) further states that this is the physical basis of consciousness and serves as a base state of human consciousness. Figure 1 illustrates my Bose-Einstein condensate; I achieved a base level of consciousness as I processed sensory inputs and operated on base instincts and emotions. This is how we all operate when we are born. Our genetic code, bodily needs, instincts, and emotions are hard wired from birth and operate on a subconscious level, as we grow and learn by processing external stimuli, we become self aware, and develop memories; this is in essence when the Bose-Einstein Condensate forms. As we continue to process sensory inputs and start to interact with others, we reach a new level of consciousness and become an individual and we continue to evolve as we grow and learn, this is how I became the person I am today and the person that I will be tomorrow. Figure 2 illustrates the formation of the quantum self that shows the interactions and relationships that cause the condensate to transition to new realities or levels of consciousness.

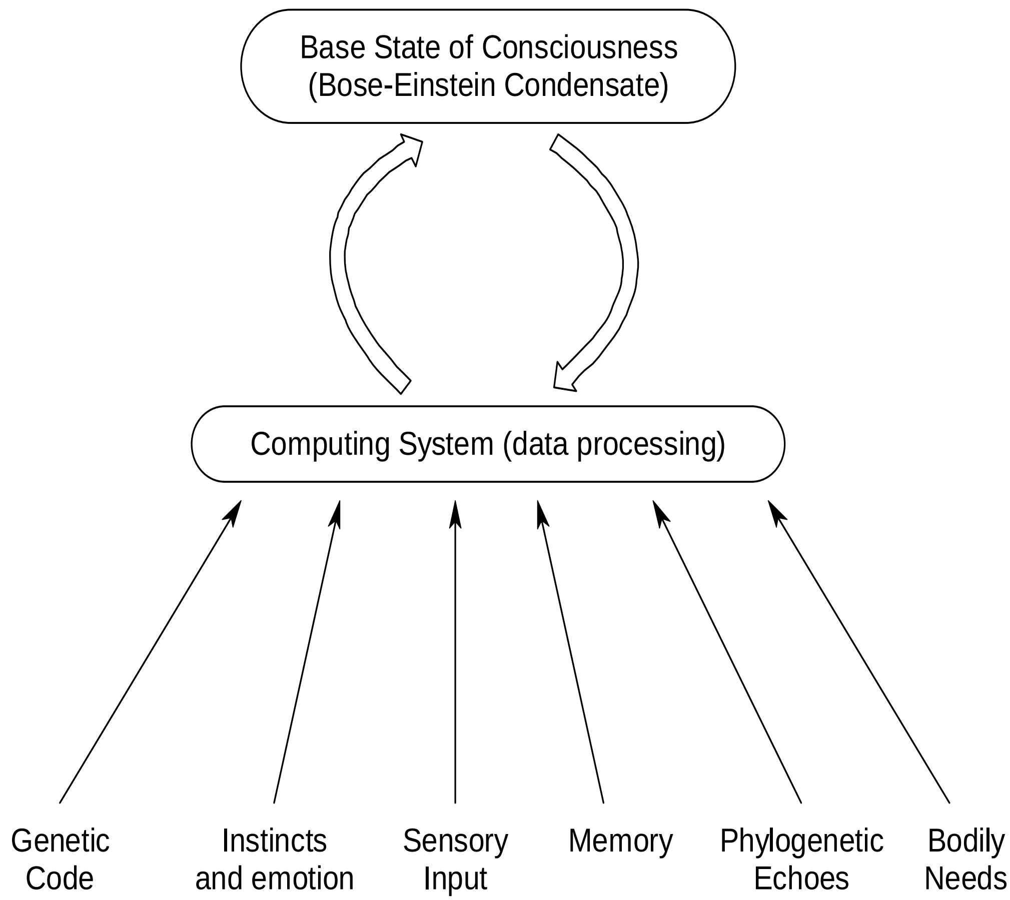

Figure 1. The Bose-Einstein Condensate. The Bose-Einstein Condensate is formed when quantum particles interact and relate to basic stimuli and evolve or transition simultaneously to form a whole entity which is a base level of consciousness (Zohar, 1990, p. 88).

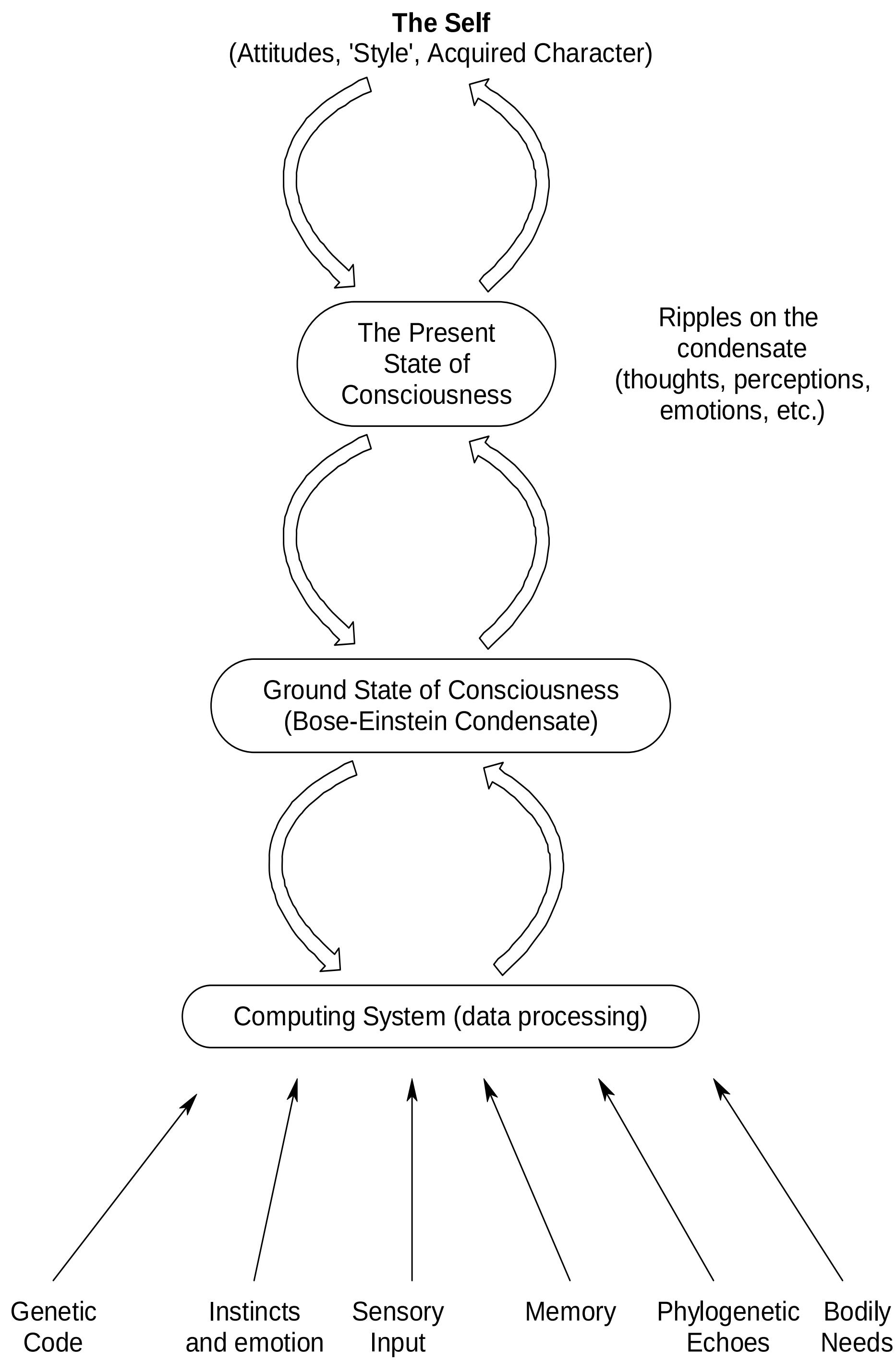

Figure 2. The Quantum Self. The quantum self is formed when a quantum entity, in the form of a Bose-Einstein Condensate, interacts with other quantum entities and transitions to new states of consciousness (Zohar, 1990, p. 88).

The model that Zohar (1990) illustrates has three levels. Level one is the data processing level that receives raw input. The raw input serves as the interactions and relationships with other particles that cause the particles to become a whole and transition to level two, the Bose-Einstein Condensate. At this level interaction and relationships with other quantum entities causes a transition to higher levels of consciousness. This is the point at which humans reach some level or state of awareness, but have yet to achieve an identity; level three is where this occurs and we become "I" or "The Self". Zohar (1990) explains that the "I" or "The Self" is formed based on quantum memories and relationships. Quantum theory states that quantum particles have no beginning and no end, so they continuously exist as a particle or a wave. Every particle that has ever existed still exists, and every particle that ever existed carries with it past and present possibilities or memories. What this implies is that we, as individuals, are shaped by our past and present to form the "I" or quantum self. The quantum self is created on two fronts, reincarnations of the past and recreation of the individual moment by moment. This implies that the quantum self or the "I" is a dynamic entity that evolves moment to moment, but is anchored to the past by quantum memories.

Development of My Leadership Theory

My leadership is the culmination of factors that formed my "quantum self". Race and gender socialization, morals and values, life experiences, and education have formed the Bose-Einstein Condensate that is essentially the person I am at this instant in time. As my quantum self interacts with other quantum entities, my level of consciousness and understanding has evolved and allowed me to develop a personal and professional code of ethics which serves as the basis for my espoused leadership. Figure 3 illustrates how this forms the basis of my espoused leadership theories. What is illustrated in Figure 3 is who I am as a person based upon my morals, values, life experiences, race and gender socialization, and new learning I have gleaned from my studies. These are the underlying assumptions of the person I am at this instance in time. The level of understanding I have achieved has enabled me to generate a personal and professional code of ethics which guide my personal and professional life. Derived from my codes of ethics is my educational philosophy, which is how I will apply my ethical codes. My educational philosophy in essence is my espoused leadership as an educator. These are the rules by which I will practice my leadership.

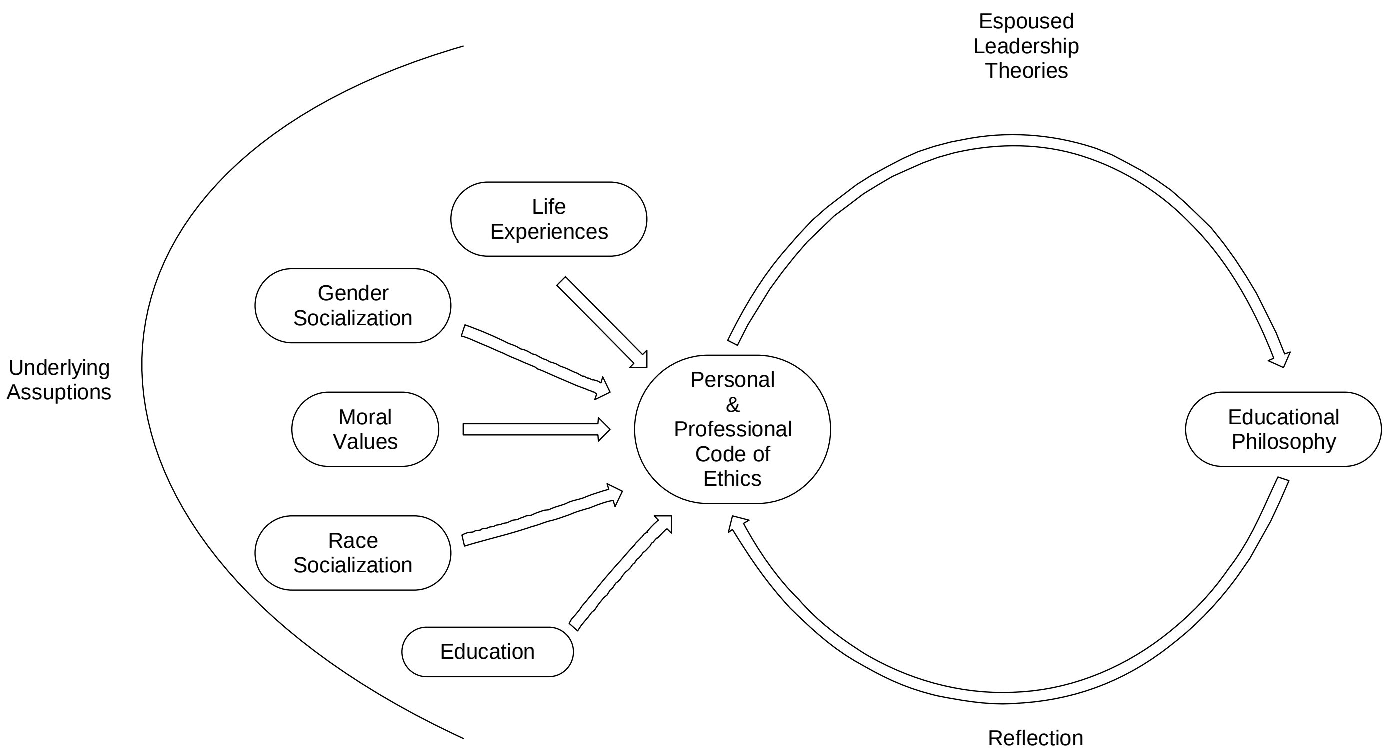

Figure 3. Espoused Leadership Theories. My educational philosophy is based upon my personal and professional code of ethics, which in turn are based upon my underlying assumptions.

Figure 4 shows how my espoused theories become my theories in use by practicing them in my profession. My theories in use are based upon Model I and Model II thinking as outlined by Chris Argyris (2001). My task as an educator is ultimately to produce technically literate, productive members of the technological society in which we live. The educational philosophy I developed as my espoused leadership is put to use in my role as an educator. Based on who I am and what I know at this instant in time, I educate students to survive life in a technological society. As this society evolves, due to pressures from technology, industry, globalization, and economics, mismatch errors occur between what my current theories in use are and what is now required to educate society's citizens as it evolves. At this point, I must break the loop of my theories in use and examine my espoused leadership, as well as the underlying basis for my espoused theories, to ensure that I remain in sync with an evolving society. This is in essence how my leadership blends into and is the basis of this participatory action research. I currently see a need to better educate all students, and in particular underrepresented students, to enable them to survive life in a technological society, so through action research I will attempt better understand my profession and my practice and seek to improve my practice by exploring new paradigms in computer science education in an effort to present it in a sociocultural light to attempt to draw more women and minorities into the major. Additionally, I will study how I change as a person and how my leadership is utilized and evolves as I progress though this study.

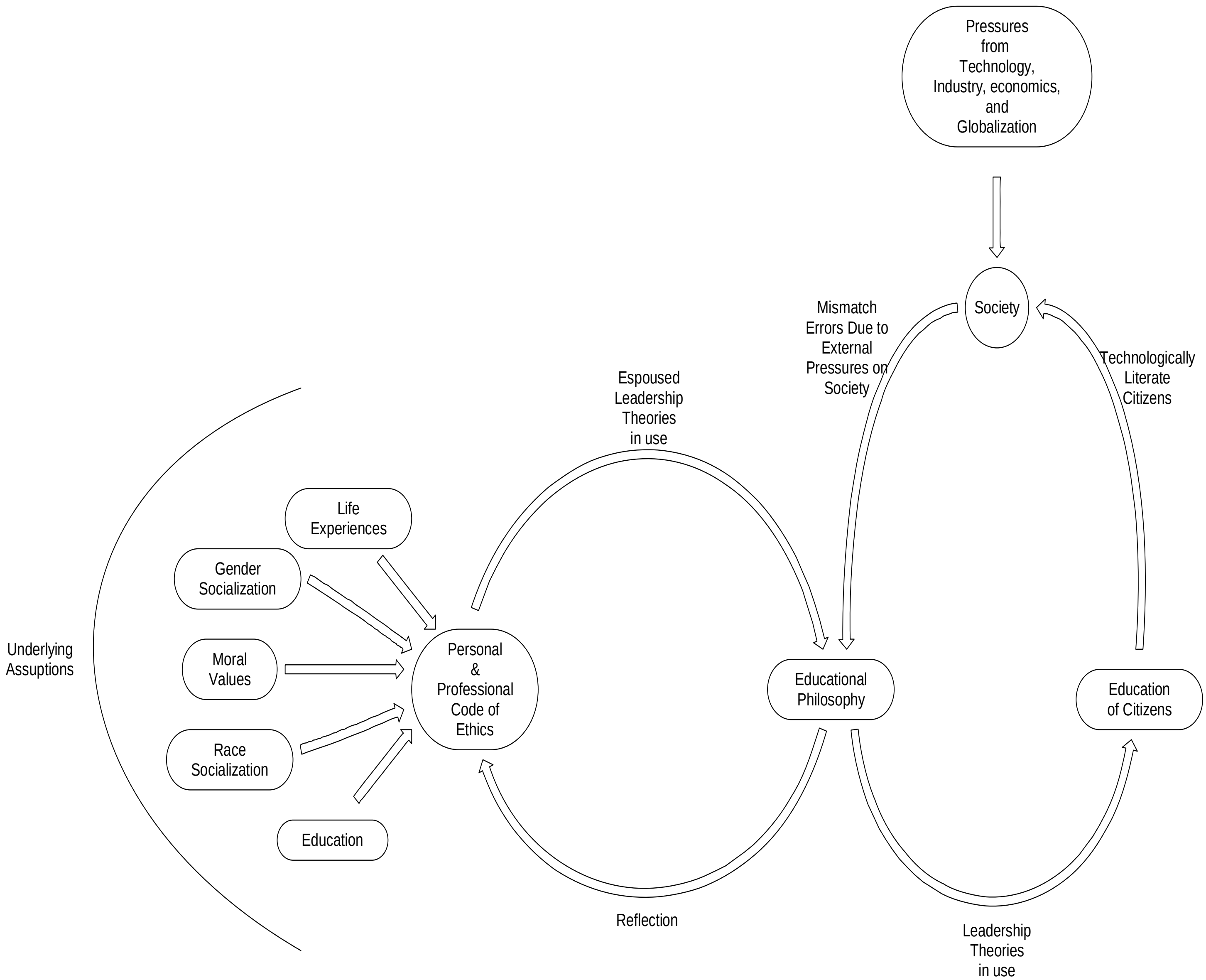

Figure 4. Leadership Theories in Use. The practice or application of my educational philosophy to use in the education of the citizens of the society we live, they become my theories in use.

Personal Code of Ethics

As educators, it is imperative that we follow personal and professional codes of ethical conduct to ensure the ideals of equity, tolerance, caring, justice, and virtue are instilled in those we teach. My personal code of ethics is based upon my understanding of right/wrong, justice, fairness, caring, tolerance, and justice.

- I will conduct myself as an ethical person in my private life.
- I will offer the insight of my combined knowledge and developed skills in a manner that is offered and received without prejudice, judgment, or predetermined notions about any individual's ability, disability, religious beliefs, sexual orientation, learning style, age, socioeconomic status, social or professional standing, gender, race, or ethnicity.
- I will refrain from any and all activities which may be construed as unethical, or which may violate written and unwritten codes of professional and personal conduct, rules, regulations and similar standards of the profession of adult education, and/or the laws of jurisdictions.
- I will continue the development of myself as a lifelong learner, and professional in my field by seeking personal knowledge, skills, and the commitment of my own potential as a learner throughout my life.
- I will promote ethical thinking and living among those whose paths I encounter in all walks of life, by conducting myself in such a manner as to set the example.

- I will actively request feedback from learners, colleagues, friends, and others on whom my actions may bear consequences in regard to my morals, values, and ethical beliefs and practices, and I will hold myself accountable for all my actions.
- I will remain conscious that I represent a profession that is the foundation for society, according to my philosophical beliefs, and I will conduct all my affairs in such a manner that will remain true to my morals and values as a person and as an educator of adults.
- I will, with great care, consideration, and dedication to my values and morals, conduct resolutions to problematic situations and ethical dilemmas, always considering the consequences of my actions in regard to all my dealings and those who may be affected.

Professional Code of Ethics

My professional code of ethics is based upon the following mechanisms and my leadership theory:

- Individuality
- Teamwork & Respect
- Discipline
- Commitment to My Profession

Individuality

The development of the individual is an important part of the learning process and must be addressed in the classroom. I allow students the freedom to express themselves and their opinions within the framework of the curriculum being taught. I believe this has a number of positive benefits. First, it creates a comfortable learning environment for the students that fosters interest and participation and allows them to grow as individuals. Secondly, I believe this fosters the development of critical thinking and the motivation to continue to learn. This philosophy in consistent with transformational/ethical leadership in the sense that I set group goals for the class and create an environment in which the individuals are important, but in which we all work toward the greater goal of becoming life long learners (Bass, 1997; Bass & Steidlmier, 1998; Couto, 1997; Hickman, 1997; Hilosky & Watwood, 1997; Jantzi & Leithwood, 1995; Koh, Steers & Terborg, 1995; Leithwood & Jantzi, 1999; Liontos, 1992; Lunenburg, 2003; Mullin & Keedy, 1998; Pejza, 1994; Robles, 1998; Turan & Sny, 1996).

Teamwork & Respect

The development of social skills is another important aspect of the educational process. The individual must learn to function in a social setting which means active interaction with other individuals. This stimulates curiosity and will tend to push the individual to higher levels of knowledge. Also developed is a tolerance for different points of view which equips the students with the skills to function in social situations and as part of a team. They learn to listen to and respect different viewpoints and opinions. This helps prepare them for scenarios they will encounter in the real world. This is consistent with feminist leadership because by encouraging the students to recognize individual's viewpoints and differences allows for relationships to develop and I create an environment where this is encouraged and nurtured (Bartunek, Walsh, & Lacey, 2000; Cancian, 1992; Grogan, 2000; Hill-Davidson, 1987; Kezar, 2000; Ropers-Huilman, 1998).

Discipline

Discipline is by far the most critical aspect of a student's success or failure. Without discipline, mastery of any subject or task is impossible. To instill discipline, students are given challenges and rewards for successful completion of the challenges. This fosters a desire to succeed and the knowledge that success is only achieved by hard work, and applying one's self to the task at hand. This is consistent with transformational/ethical leadership in the sense that I believe that the students' desire to succeed is internal and by setting goals to reach for, the students will have the discipline to obtain the rewards of reaching the goals set (Bass, 1997; Bass & Steidlmier, 1998; Couto, 1997; Hickman, 1997; Hilosky & Watwood, 1997; Jantzi & Leithwood, 1995; Koh, Steers & Terborg, 1995; Leithwood & Jantzi, 1999; Liontos, 1992; Lunenburg, 2003; Mullin & Keedy, 1998; Pejza, 1994; Robles, 1998; Turan & Sny, 1996).

Commitment to My Profession

Having personal and professional codes of ethics only means that I have a framework to follow in my personal and professional lives. In addition I must also be committed to the ideals I espouse. My commitment to my codes of ethics is practiced by following the commitments to myself and my profession as outlined below.

- I will conduct myself as an ethical person, while subsequently refraining from unethical activities, in my private life, and as an ethical professional when dealing with learners, colleagues, parents, and others on a daily basis.
- I will recognize the importance of the teaching process because it directly influences society and its citizens. In this pursuit I will stay current with new teaching methods to enhance the educational process.

- I will be honest, fair, and respectful of others in my professional affairs so as to inspire the trust and confidence vested in me.
- I will use this trust and confidence to develop authentic professional relationships that encourage a positive learning environment for students and staff.
- I will revisit my code of ethics at reasonable intervals and reflect on my professional actions making corrections and improvements as I deem applicable in order to benefit the learners, the profession, and the teaching process itself.

Educational Philosophy

My educational philosophy is based upon my personal and professional code of ethics. My code of ethics encompasses the person I am and my values. By grounding my educational philosophy in ethics, I seek to avoid the dangers of transformational leadership (Bass, 1997; Bass & Steidlmier, 1998; Couto, 1997; Hickman, 1997; Hilosky & Watwood, 1997; Jantzi & Leithwood, 1995; Koh, Steers & Terborg, 1995; Leithwood & Jantzi, 1999; Liontos, 1992; Lunenburg, 2003; Mullin & Keedy, 1998; Pejza, 1994; Robles, 1998; Turan & Sny, 1996). Critics of transformational leadership argue that it is unethical because it may lack the checks and balances of a democratic society and may cause the individual to ignore their own interest and follow the self interest and moral values of the leader, but a true transformational leader is a moral agent who reflects upon underlying assumptions and the good of the group as a whole. The true transformational leaders' main goal is to foster an environment in which the individual is important, taking into account the individuals' beliefs and values, as well as the beliefs and values of the group, and the shared vision of success and moral/ethical uplifting in the end goal (Bass, 1997).

Integral to my educational philosophy is the notion that each student is a unique individual and must be treated with respect. The development of the individual is an important part of the learning process. I allow students the freedom to express themselves and their opinions within the context of their values and beliefs to create a comfortable learning environment for the students that fosters interest and participation and allows them to grow as individuals. Secondly, I believe this learning environment fosters the development of critical thinking and the motivation to continue to learn. I am teaching the individual how to learn. I treat the individual as an extension of myself, which allows me to learn and improve myself. This learning environment also requires mutual trust between the teacher and the student. The instructor should not just impart knowledge, but should encourage the mutual exchange of knowledge through dialogue between the teacher and the student. This dialogue should be based upon on trust and mutual respect. In an environment where this is not the case, the teacher inhibits the development of social skills.

The end goal of my educational philosophy is to produce individuals who strive for excellence for themselves, their peers, and the society in which they live. As an educator, I am morally and ethically bound to this goal. By developing the individual, students are equipped to understand that they can make a difference and will carry these ideas into society with the understanding that improvement of the individual is improvement of society (Aron, 1977; Paolitto, 1977).

Chapter 3

Literature Review

> The future is not a result of choices among alternative paths offered by the present, but a place that is created--created first in the mind and will, created next in activity. The future is not some place we are going to, but one we are creating. The paths are not to be found, but made, and the activity of making them, changes both the maker and the destination. - John Schaar

New Educational Paradigms

Technology and everyday life are becoming intertwined. The ability to transfer or obtain information from anywhere in the world has led to a global paradigm in many sectors. Organizations no longer function from centralized locations; they have become virtual organizations with offices and personnel located wherever resources and clients are found on the planet. Students no longer need to attend classrooms, but can learn in a virtual environment. This global paradigm in education is changing traditional methodologies and curriculum in an attempt to meet the needs of a new global society.

Technological advances are placing pressure on many traditional icons, including educational icons. Traditional teaching pedagogies and traditional curriculum are being forced to change to keep pace with the technological society in which we live. The audience has changed, new disciplines have evolved, the work force has changed, and industry has changed because of technological advances. Haneline (2000) explores the pressures that faculty face by looking at changes that are occurring in a higher education setting as related to faculty development. Traditionally, faculty development was addressed as release time for travel, scholarship, and research. There was no need to train faculty because they were considered experts in their disciplines and experts in curriculum delivery; additionally, they performed collegial self-assessments to gauge their performance and the progress of the students. This model of faculty development was grounded in the context of the expertise and skill levels of the faculty and student bodies of the time. Changes in the student body, due to changing technology, has created a new paradigm in which students have a higher level of technological sophistication. This new level of sophistication requires faculty be adequately prepared to serve students' needs. Higher skill levels and continued professional development are required of faculty to keep pace with technology and the sophistication level of the students. The new context also requires new assessment methodologies be developed to adequately gauge the progress of student and faculty performance during an age in which information is readily available (Haneline, 2000).

Research by Miller & King (2003) found that the people who make up a virtual classroom are a group of diverse individuals, and the different learning styles of each individual must be taken into consideration. The individuals must also possess common qualities to be successful in a virtual learning environment. The students in a virtual classroom are typically non-traditional students who are motivated, disciplined, and serious about learning. These characteristics are required for a student to be successful in a virtual classroom because the material is digested at the individual's pace. This means that the individual should also have good communication skills because interaction with the instructor and the classmates is done in a virtual arena where written communication is the primary form of contact. The role the instructor plays takes on great importance in the success of the virtual classroom because just as in a face-to-face classroom the instructor must provide clear, concise and timely feedback (Miller & King, 2003). This also implies that the instructor must be versed in the technology used and pedagogical methodologies. I believe that this also illustrates the diversity of learning styles that are a part of any learning environment due to the socioeconomic backgrounds of the student population.

The virtual classroom is vastly different from a traditional classroom and innovative pedagogical practices are needed to adequately prepare students. The term pedagogy and the term innovative are the practices that provide students with skills and competencies that they need to become life long learners in the information society of the next century. Trends and patterns that students and teachers utilize in using information and communication technologies (ICT) should reflect new curriculum goals, and how these practices change an organization. Technology is supporting significant changes in classroom teaching and learning. Students are now actively engaged in constructivist activities, such as searching for information, designing products, and publishing or presenting the results of their work, but overall, technology supported innovations have a limited impact on curriculum. The factors attributed to this center on the energy and commitment of teachers, student support, the perceived value for the innovation, the availability of teacher professional development opportunities, and administrator support (Kozma & Anderson, 2002).

Other issues that impact ICT enabled learning in organizations are cultural, ethical, and social in context. As organizations rush to adopt ICT curriculum and pedagogies, there are many pressures against ICT initiatives on a social and cultural level. Pressure from faculty who are reluctant to adopt ICT is one of the major obstacles.

There is an ongoing debate among faculty about whether ICT will dehumanize the teaching and learning experience. Holden (1999) argues that the opposite is true if faculty understand the technology and utilize it to create new opportunities for human interaction. The virtual learning environment is no different from a traditional classroom and can still be tailored to individual needs and goals based upon interactions through technology. Learning environments are essentially constructed under the same set of rules, regardless of the context in which they are constructed. Students need to be actively engaged in the construction of the learning environment, which implies that e-learning environments must be designed to sufficiently motivate the students to participate. This is no different than the pedagogy employed in a face-to-face classroom. The teacher must motivate the students to take part in the construction of the learning environment. Sufficiently motivated students are satisfied, yielding maximum participation, and the same is true in a face-to-face learning environment. The faculty notion that ICT will decrease their role in teaching is a false perception. The use of ICT should provide teachers with more time to spend with the students, in a virtual or non-virtual setting, ICT should provide more time to analyze and handle individual differences because of greater access to students, and more time to pursue scholarly activities because of the freedom afforded by ICT. The faculty perception that ICT will lead to a decrease in the number of teachers and an overall reduction in salaries for teachers is not true. Faculty using ICT should have more time to pursue other interests such as mentoring, research, and collaboration. This freedom results because teachers are no longer bound by time or presence in a virtual world and with opportunities to collaborate and pursue knowledge and research, their worth should increase. Also, the attractiveness of faculty positions free of the time constraints, versus those in industry, should potentially attract greater numbers into the educational field. Yet, how can traditional culture be changed and how is an environment created in which ICT is used effectively? The answers to these questions can be found in the way e-learning environments are designed. They must provide the same motivation and rewards that are perceived to be available in the face-to-face classroom (Holden, 1999; Miller & King, 2003; Warner, 2003).

Society and education have been transformed due to technology and the pressure it brought to bear on traditional paradigms in education and technology. The technological transformation of education brings to the surface many issues that must be addressed. As technological advances challenge traditional educational paradigms, there is a need to evolve to meet the needs of a global, technologically sophisticated audience. There is also a need for teachers who are sufficiently knowledgeable of the technology initiatives and new educational paradigms. Additionally, the virtual learning environment must still offer similar learning experiences that were available in physical learning environments. Finally, the ethical behavior of the individuals should not change because of the freedom that virtual environments offer. Therefore, as educational paradigms embrace technology, a new framework must be developed that ensures the same outcomes that are available in traditional education.

Educational Issues Faced by Underrepresented Students in a Technological Society

The evolving paradigms in education introduce many new challenges for disadvantaged students. These groups must be provided with the information and skills to succeed in science, math, and engineering education in order to keep pace with life in a technological society. Providing the underrepresented groups the means to decide to pursue degrees in math, science, and engineering, equips them with the ability to become future workers, educators, and scientists who will add much needed diversity to these professions.

Women and minority students face similar dilemmas when deciding to pursue math and science majors in higher education, such as poor preparation, limited access to resources, gender and race socialization, lack of confidence, and a lack of mentors (Beyer, Rynes, Chaves, Hay & Perrault, 2002; Cardinale, 1992). Underrepresented groups typically are not sufficiently prepared to pursue math and science degrees because of poor math skills and limited computer use. Female perceptions and attitudes toward mathematics and computer use differ from those of males and leads to avoidance of mathematics and computers (Kramer & Lehman, 1990). Females also tend to see mathematics and computer science as a male dominated field and feel that excelling in these fields tends to bring their femininity into question (Durndell, Siann & Glissov, 1990; Schubert, 1986). Other factors that influence the majors females choose include when they first used computers, their parent's occupations, and the influence of teachers, role models, and mentors (Turner, Bernt & Pecora, 2002; Ware & Lee, 1988). Minority students must overcome obstacles similar to those faced by female students such as poor perceptions of self, low aspirations as the result of past race socialization, socioeconomic factors, poor academic preparation, and previous family and schooling experiences (McCormick & Williams, 1974; Thomas, 1985). All of these factors form a social context that places new pressures on traditional education. New paradigms in education for underrepresented students need to be developed so that meaningful learning environments can be developed in a context in which these students will thrive.

The power of social context and its effect on the technology driven pedagogy and curriculum is the power of how the development of the learning environment is impacted. A society is made up of individuals with different beliefs and identities. The individuals in a society interact with each other and develop similar interests and knowledge. Individuals with shared knowledge and interests tend to band together and form groups, and then the groups interact and merge with other groups to form organizations. In the context of learning environments, these same interactions and creation of groups takes place, but the impact is that the groups and organizations that form because of these relationships can have a positive or negative impact on the construction and perceptions of the learning environment.

Social issues such as age, race, and gender impact the success or failure of learning environments. Garrison and Bromley (2004) found that age, race, and gender all play a part in how the learning environment is impacted because each area has a different set of perceptions and shared knowledge. The age of the individuals in a group determines how preconceived notions about technology and technology driven education may impact the level of buy-in or participation that certain individuals or groups are willing to allow. The same can be said for race and gender. In each category there are certain shared beliefs and ideals that the members of a group hold as the basis for their actions and the basis for how they learn and how they participate in the construction of their learning environments. These beliefs can have a positive or negative impact on the learning environment. The interrelationship between the social context of technology use and the effects it can have on the learning environment is typically a negative impact on the technology driven learning environment because of policies on technology use, teacher views and pedagogy, and student practices. The policies that organizations implement are based on the shared beliefs and knowledge of the individuals and groups that make up the organization. These policies may not provide the support structure needed to adapt technology driven education and these policies can lead to the success and failure of initiatives that look to use education and technology in a sociocultural context (Garrison & Bromley, 2004).

The ethical challenges faced in establishing technology driven learning environments centers on respect for individual feelings and individual opinions. Learning environments are comprised of individuals who interact with each other. There are unwritten rules of conduct and rules of etiquette that govern these interactions and there is a mutual respect for others' opinions and feelings. Without this mutual respect, there is no infrastructure in place to construct learning environments. Yet, in a virtual environment, there is no physical presence, which could lead to a diminished fear of embarrassment or repercussions. The possibility also exists for less constraint when voicing opinions or interacting with others. How can technology enabled pedagogy be structured to address this ethical dilemma?

The diverse audience that comprises technology driven learning environments due to the deconstruction of geographic and time constraints implies that the audience in these learning environments is global by nature, with many different cultures, social contexts, learning styles, and languages. Technology enabled pedagogies and curriculum must be structured to accommodate this wide variety of individuals. Ethically, this means that the various individuals must have the respect and forum to freely espouse their beliefs and opinions without fear of ridicule or belittlement in order to effectively participate in and help construct a learning environment.

Zembylas & Vrasidas (2005) believe that pedagogical practices in technology enabled learning allow interactions that are part of the learning environment, but enable the faculty who design the environment and the students who participate in the learning environment the room and flexibility to create a meaningful learning experience. No group or individual should be excluded from contributing to this process due to cultural, racial, geographic, or gender differences. Technology enabled pedagogies should serve as the inter-face that provides the same context for interactions as would be found in a face-to-face environment. Thus, the same rules and etiquette that apply in face-to-face learning are applicable in e-learning. Individuals must be recognized and given the freedom to express themselves regardless of social and cultural differences (Zembylas & Vrasidas, 2005).

The ethical issues involved in technology driven learning means that new and innovative programs and pedagogies must be established to adequately address the diverse audience that will participate in technology enabled curriculum. With the pressures that technology is placing on the educational system, there may be a need for traditional pedagogies and curriculums to evolve. This would possibly mean the need to re-assess current degree programs to ensure they address the needs of an e-learning community. Historically, universities have been somewhat aligned with the needs of industry and structure their programs around these needs. Of course, there is still the need to produce researchers and thinkers, but the vast majority of college students attend college to gain training in a field that is related to the environment in which they live.

Vocational schools fill the need of specific training for specific jobs, but universities and colleges serve a dual purpose. Higher education institutions must supply industry with graduates that fill their needs, but must also produce a viable number of teachers, researchers, and scientists to teach the next generation of teachers. The diversity of the audience in e-learning environments now means that the pressures universities face are global in context. Technology driven learning environments are not constrained by geographic location. This means that learning programs must provide the needs of global clients. Industry and research demands placed upon these institutions are not regional, but global, implying that the programs must also be global in nature. The case can be made that as universities continue to adapt technology enabled education, the programs must evolve to accommodate a global clientele. New programs will need to be developed with the flexibility to change as the global audience they serve evolves and changes (Malfroy & Yates, 2003).

Trends and Challenges Faced by Computer Science Education

Computer science education faces many challenges due to advances in technology. Computers are more powerful, memory and storage capacity has more than quadrupled and is relatively inexpensive, and globalization has created a new audience with new demands. Traditional computer science education is based upon the study and practice of information modeling and the procedures or algorithms that allow for the transformation of this information. Based upon my knowledge of computer science and my anecdotal observations as a professor of computer science, traditional computer science students are educated to study the phenomena in computer science with little or no experience in the applications of computer science theory and practices. Advances in technology have led to many pressures coming to bear on traditional computer science education. Figure 5 illustrates the pressures that traditional computer science education face.

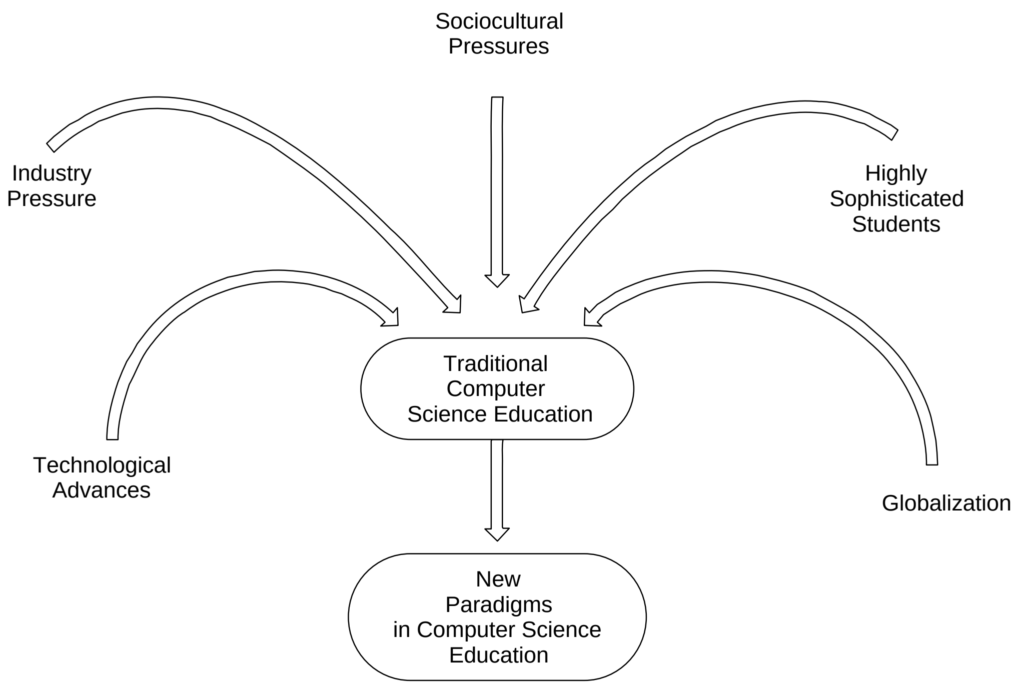

Figure 5. Computer Science Education. Pressures on traditional paradigms in computer science education.

The pressure from industry that is being applied on computer science education is the demand to produce well-trained instead of well-educated graduates. This is a vocational model of education. The growing influence of industry and its power to dictate the direction of education has caused a fundamental shift from one of culture to a more industrial model and the importance of economic gain has overshadowed educational pedagogy. This means that academic institutions now are more sensitive to the needs of industry, which typically supplies large endowments, rather than being sensitive to the long term needs of the students, but the monies received from industry come with strings attached in the form of future directions geared towards supplying the benefactors with a constant supply of graduates skilled in the areas deemed important by industry. Traditionally, students were trained not in a specific vocational field, but were taught to be long term thinkers and lifelong learners. The dilemma is therefore how to maintain the traditional paradigms and serve the needs of industry and society. This brings up the need for re-evaluation of the current and future roles that computer science education will play. With the deconstruction of economic, geographic, and social barriers due to technological advances, no institution can survive in isolation, and must evolve to meet the needs and demands of society (Santini, 2004).

Today's students are also more sophisticated due to technological advances. The current world of computing consists of distributed control, multitasking, objects and agents, high speed Internet connections, and parallel processing. This implies a new paradigm in computing verses the traditional sequential, one step after another model of computing. It is necessary for educational institutions to supply graduates who are trained to interact and function in this new technological society. The students graduating in computer science today need to know how to work in complex programming environments and how to manage complexity in a much different manner that their predecessors. This means that computer science education must evolve to meet these new paradigms in computing.

Looking from the inside out, there is a great debate on the role of computer science education. As industry demands increase for well-skilled instead of well-educated graduates, many institutions have developed new programs to meet these needs. As little as ten years ago there was no MIS component of Business administration, or Chief Information Officers, or Playstations and X-Boxes, but now technology has become an integral part of our lives. Computer science education is traditionally a liberal arts science and not a vocational science, but it may be time to re-evaluate the role of computer science education. What has occurred is that as computer science educators struggle to maintain the pure science aspect of the profession, they are increasingly perceived as a service department that enables programs that churns out graduates that are well-trained versus well-educated. The payoff for computer science is that large numbers of students will be taking these service courses, but the core of what computer science teaches is still the same model as it was in the past. The service courses are the result of computer science educators' inflexibility to adapt and change with the rest of society as they struggle to remain in an academic shell of pure science while the world moves on without them (Wegner, 1972).

Additionally, there is a need to provide computer science education in a sociocultural context. Computer science education presented in a sociocultural context will ensure that underrepresented students are prepared to survive and actively participate in a technological society. This model of computer science takes into account how students learn and the context in which they learn. This determines how they construct their knowledge of computer science and it is different for different cultures. Computer science must be taught in a context that allows students to incorporate their life experiences and cultural knowledge's into the construction of their knowledge (Jungck, 1990). Educators must also embrace new paradigms that incorporate a sociocultural framework. Educators must look at traditional computer science education through a critical eye to ensure that conditions are conducive for underrepresented students to construct meaningful learning environments. Traditional pedagogy and curriculum fails in many instances to keep pace with the change pressures on education caused by technology. Educators in a technological society must be aware of these issues and foster the development of knowledge and skills in a sociocultural context (Evans & Elium, 1982; Forsythe, 1968; Goodson & Mangan, 1996; Hanley, Terpstra, Gillaspy & McCoy, 1983; Knuth, 1974; Lockheed & Mandinach, 1986; Orchard, 1975; Ruthven, 1984; Wyatt, 1985).

The Role of Summer Bridge Programs

The population of America continues to become more diverse. Census projections indicated that by the middle of the century 47% of the population will be people of color (Blake, 1998). This diversity in the population means that educational opportunities must exist for all people. The federal government initiated programs in the 1960's to address the issues of economic and educational disparity. The Economic Opportunity Act allowed for the creation of many programs under the umbrella name of TRIO. These programs were designed to provide minority and under privileged students educational opportunities that they would not otherwise have access to. The TRIO programs that were initiated as the result of the government initiatives are Upward Bound, Talent Search, Student Support Services, Educational Opportunity Centers, Staff and Leadership Training Authority, The Ronald E McNair Post-Baccalaureate Achievement Program, and Upward Bound Math/Science Program. The focus of all of these programs is to increase the enrollment, retention, and success of low-income and minority students (McElroy & Armesto, 1998).

Early intervention plays an important role in the decision to attend college and the success and graduation rates of underrepresented student populations. Perna (2003) argues that academic preparation in pre-college education is a key factor in college enrollment and success. Historically, minority and low-income students are placed at a disadvantage because they are less likely to be prepared to attend college. This is due to the fact that the coursework in K-12 institutions that service these students do not offer high quality programs. In addition to pre-college intervention programs, Perna and Swail (2001) also stress the importance of government efforts to aid in the funding of these programs. The TRIO initiatives and federal grants and loans have provided low-income and minority students with opportunities and access to higher education and has lead to increased parent awareness and involvement with these programs. Another benefit of the TRIO initiatives is collaboration between K-12 and higher education institutions in an effort to provide pre-college programs to the students of low-income and minority households.

The advantages of the partnerships between K-12 and higher education institutions have served to better prepare students on a pre-college level and to increase the enrollment rates of minority and disadvantaged students, but these partnerships do not guarantee the academic success or graduation rates of the students. This is due to a lack of focus at the higher education level. There is still a need for reform and more funding in higher learning institutions to ensure programs are in place that will help the students' success at the secondary and post secondary levels (Laguardia, 1998).

Another disadvantage that minority and disadvantaged students face is the math courses they participate in at the high school level. Davenport, Davison, Kuang, Ding, Kim & Kwak (1998) found that comparisons of various ethnic groups indicated that African American and Hispanic students have the highest participation in lower level math courses when compared to White and Asian students. This lack of participation in higher level math courses reinforces Pernas' (2003) argument that minority and disadvantaged students are not sufficiently prepared at the pre-college level for success in higher education.

Early intervention at the pre-college level helps low-income and underrepresented students to better prepare for college. Once these students reach college they are less likely to stay in college and less likely to receive a degree. The cause of high attrition rates and poor academic performance for this population of students can be correlated to a number of factors, such as adjustment difficulties to college life and inadequate preparation to handle the rigors of college level curriculum. One component of the TRIO program, the Student Support Services, is designed to increase the graduation and retention rates of disadvantaged students by providing opportunities for academic development and creating an environment that encourages the success of disadvantaged students (Chaney, Muraskin, Cahalan, & Goodwin, 1998).

Poor academic performance of disadvantaged freshmen students is one factor in the high attrition rates of low-income and minority students. In an effort to meet the federal guidelines of the TRIO programs, many higher education institutions enrolled low-income and minority students who typically did not meet the standard entrance requirements. These students suffered from poor academic pre-college preparation and adjustment difficulties to the college environment. Obler, Francis & Wishengrad (1977) saw an experimental program developed by Brooklyn College, CUNY as an answer to the issues faced by disadvantaged freshmen. The SEEK program developed by CUNY combined counseling, mentoring and instruction in an effort address issues that they felt were lacking in traditional colleges. The faculty at CUNY were specially trained to offer counseling and tutoring to students, in addition to their teaching responsibilities. CUNY felt that these new methodologies would improve the retention and success of disadvantaged students.

In addition to counseling and tutoring, a number of programs were developed to help improve the retention of disadvantaged students. Summer programs that were aimed at helping these students bridge the gap between high school and college were implemented by a number of colleges and universities across the nation. The success of these summer bridge programs has demonstrated a positive effect on the students who participate. Outcome evaluations are used to gauge the design, implementation, and success of the summer bridge programs. York and Tross (1994) view evaluation of the summer bridge programs as a critical component in determining the effectiveness of a bridge program. Evaluating summer bridge programs requires longitudinal outcome assessments, because the goal of these programs is to increase the success and graduation rates of the participants. This information can only be obtained by following the students' progress throughout their college career. Another area that can be explored to assess the effectiveness of summer bridge programs is the role they play in parents perceptions of the programs and what impact this will have as their children progress through college. Zulli, Frierson, and Clayton (1998) found that parents' involvement in the academic programs in which their children participate helps them to gain a greater appreciation of the programs and to be more supportive of their children's academic efforts. This in turn encourages the students to continue pursue their educational goals.

The common feature of the majority of these programs is that they take a disciplined approach to teaching the survival skills necessary to succeed in college. Participants have the opportunity to earn college credits during the summer programs by participating in course work, structured study periods, group discussions, and other activities that promote academic and personal success. The overall goal of all of the summer bridge programs is to better prepare disadvantaged students academically to face the rigors of college level coursework and to help them to adjust to the college environment. These factors in turn increase the retention and graduation rates of disadvantaged students (Ackerman, 1991a; Ackerman, 1991b; Ami, 2001; Buck, 1985; Evans, 1999; Fitts, 1989; Garcia, 1991; Suhr, 1980).

Outreach programs to improve student performance, starting at the K-12 levels, and bridge programs to improve the enrollment, success, and retention of minority and low income students in higher education institutes are two examples of programs implemented by many colleges across the nation (Garcia, 1991; Laguardia, 1998; McElroy & Armesto, 1998). Rowan University has implemented a summer bridge programs to address the issue of underrepresented minorities and retention rates. Rowan University's' Pre-College Institute (PCI) is comprised of two components, the Educational Opportunity Fund (EOF) for students from low income families and Maximizing Academic Potential (MAP) for students who failed to meet the minimum entrance requirements, but show academic potential. Incoming EOF/MAP students attend an intensive five-week PCI held on campus from July to mid-August. The Institute takes a disciplined approach to teaching the survival skills necessary to succeed in college. Participants have the opportunity to earn college credits during the summer institute.

Students participate in course work, structured study periods, group discussions, and other activities that promote academic and personal success. At the end of the Institute, EOF/MAP staff evaluates all student performance records then recommends retention or denial of admission to Rowan University. Thinking about new paradigms in computer science education, one possibility is to combine the focus of summer bridge programs with the need to present computer science in a sociocultural context. The combination of these concepts leads me to create a program or pipeline that would provide intervention, community, and mentoring and role models to facilitate the success and retention of students.

In summary, the combination of early intervention, academic preparation at the pre-college level and summer bridge programs all play a role in the enrollment, retention and graduation rates of underrepresented students in higher education institutions. Traditional paradigms in computer science education must be redefined to provide equal access for underrepresented students. This study sought to understand the factors that tend to drive students away from computer science and to formulate a plan to address the flight of underrepresented students from the major. The ideas proposed in this study can only be accomplished by examining mental models or underlying assumptions and attempting to influence or change them. In order to accomplish this change, first and second order change must occur. First order change is a short term shift in thinking and second order change is a permanent change in thinking. Only through second order change will new ideals and behavior become sustained (Bartunek & Moch, 1987; Bartunek & Moch, 1994).

Chapter 4

Methodology

Introduction

The success of minorities and women in the future depends upon their computer literacy. Computer science education needs to be viewed in a sociocultural context, in which the end goal is to provide all students with the needed skills and the capacity to survive life and be productive members of a technological society. This is especially essential for underrepresented students if they are to assume future roles as educators, researchers, and workers in a technological society. In order to facilitate the success of underrepresented students in computer science, a pipeline needs to be established to deliver a continuum of minority and female students to fill the roles of workers, educators, and researchers, and to serve as mentors and role models for future generations of minority and female students.

This study sought to answer multiple questions, using quantitative and qualitative data, centered on the need to entice more minorities and females into computer science at Rowan University. This study employed a mixed mode action research design that consisted of multiple cycles. Mixed mode action research (Creswell, 1998; Patton, 2002), using qualitative and quantitative methods in conjunction, provide complementary data sets which together give a more complete picture than can be obtained using either method individually. Figure 6 illustrates the cycles involved in this research study and shows how one cycle flowed into and influenced the next. This model of the project is typical of action research, which was first created by Kurt Lewin (as cited in Smith, 2001). The approach he outlined was a series of steps or spirals that involved planning, taking an action, and reflection or evaluation of the outcome of the action (Smith, 2001).

The use of action research to deepen and develop classroom practice has grown into a strong tradition of practice (Feldman, 2002; Johnston, 1994), but for some there is an insistence that action research must be collaborative and generate knowledge (Kidd & Kral, 2005). Action research can be a form of collective self-reflective inquiry undertaken by participants in social situations in order to improve the rationality and justice of their own social or educational practices, as well as their understanding of those practices and the situations in which the practices are carried out. The generation of knowledge and collaboration is not the only ends to action research, but improving society through the improvement of its citizens as another goal (Furman, 2004).

In this context, it is safe to assert that as educators, our goal is to improve a society through the education of its citizens, and for educators to improve and better educate individuals, they must understand and improve themselves and their practice; action research, by its very nature, is the perfect vehicle for accomplishing these tasks. Within this context, I also explored myself and my leadership, so a component of this study was to explore my leadership, the person I am, and how the application of my leadership was used to help improve the interest and enrollment in computer science at Rowan University.

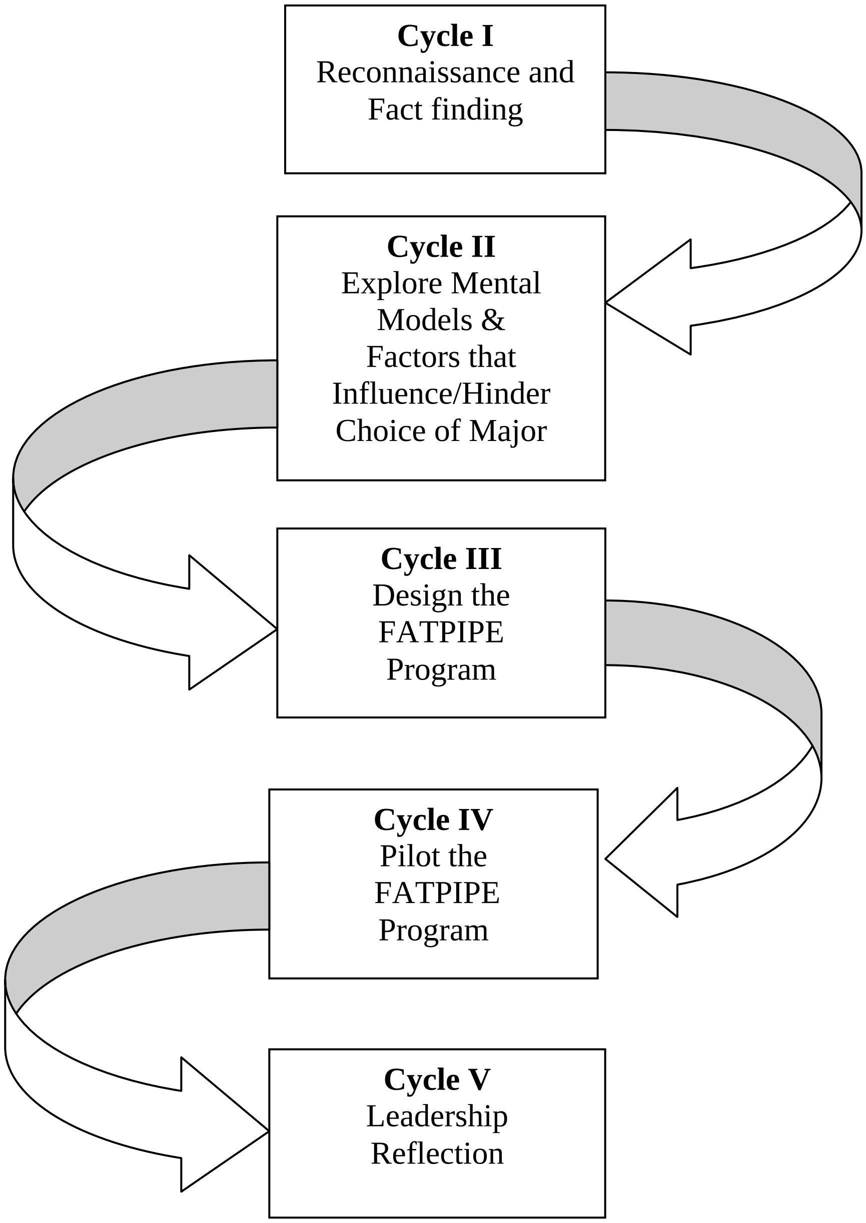

Figure 6. Action Research Cycles. The four cycles of this action research study on closing the race and gender gaps in computer science education at Rowan University.

Participants

The participants in this study were students from the PCI program who had been exposed to five full weeks of the program at the time when I distributed a survey. This group of students was chosen as both a purposeful sample, and a sample of convenience (Patton, 2002). The demographics of the PCI program consist of a large population of underrepresented students making it convenient in terms of targeting this group as a means of increasing diversity in the computer science major. The sample was purposeful in the context of understanding the mental models of computer science for underrepresented students.

Data Collection Strategies

Quantitative data was gathered from a survey instrument to determine the participants' perceptions of their math preparation, the ability to succeed in computer science, and the role that race and gender socialization played in their mental models of computer science and their ability to succeed in the major. Demographic data was also gathered, as well as the students' choice of major. Qualitative data from journal entries of the participants was used to document thoughts from the students over the course of the summer PCI program as they engaged in reflective practice. Qualitative entries from my leadership journal and field notes documented my leadership and the processes that were used as I practiced my leadership over the course of the study.

The Study Site

This study was conducted at Rowan University and what follows is short history of Rowan as documented on the colleges' website.

Rowan University has existed since 1923 in various forms. Originally, it was a normal school with a mission to train teachers for South Jersey classrooms, and today it has evolved into a comprehensive university with a strong regional reputation. Today, Rowan University is divided into a Graduate School and seven academic colleges: Business, Communication, Education, Engineering, Fine & Performing Arts, Liberal Arts & Sciences, and the College of Continuing and Professional Education. Rowan's nearly 10,000 students can select from among 36 undergraduate majors, seven teacher certification programs, 26 master's degree programs and a doctoral program in educational leadership. The tree-lined campus contains 42 buildings, including eight residence halls, three apartment complexes, a Student Recreation Center and 23 computer labs.

Rowan is in the midst of an aggressive 10-year plan that will give the university a national reputation for excellence and innovation and will make it the public university of choice in the region. The plan calls for a greater campus-wide focus on academic and student support initiatives as well as more that $536 million being spent on campus construction and renovation projects, including a $45 million science building, which opened in 2003. New residence halls are being built to allow the University to become a traditional residential campus.

In 2001, the University received a $6 million grant from the state Economic Development Authority to construct a Rowan Technology Park, which will play a significant role in the economic development of the region.

Over the years Rowan has earned a reputation as a high-quality, moderate-price university. These efforts have caught the attention of national organizations that

> evaluate colleges and universities. US News & World Report ranks Rowan University in the "Top Tier" of Northern Regional Universities. Kaplan included the University in "The Unofficial, Biased Insider's Guide to the 320 Most Interesting Colleges." Also, Kiplinger's named Rowan University one of the "100 Best Buys in Public Colleges and Universities" and the Princeton Review included Rowan in the latest edition of "The Best Northeastern Colleges."
>
> From the modest normal school begun more than 80 years ago, Rowan University has become an extraordinary comprehensive institution that has improved the quality of life for the citizens of New Jersey and the surrounding states.
>
> From the modest normal school begun more than 80 years ago, Rowan University has become an extraordinary comprehensive institution that has improved the quality of life for the citizens of New Jersey and the surrounding states (http://www.rowan.edu/subpages/about/history/).

What this history shows is that Rowan University is committed to the community where it resides, the students who attend Rowan University, and to the society which it serves.

The Computer Science Department also mirrors the commitment that Rowan University has to its students and society as reflected in the mission statement from the Computer Science Department website:

> The Rowan Department of Computer Science strives to provide high-quality educational programs in the theory and practice of Computer Science. The Department is committed to creating a student-centered learning environment that promotes close student-faculty relationships and enhances the intellectual development of both students and faculty.

> Our nationally accredited BS program offers challenging and stimulating learning experiences and produces future Computer Science leaders and innovators. The department also meets the needs of the larger community by offering general education courses, a minor in Computer Science, and other educational programs. The Computer Science faculty is committed to contributing to the expansion of knowledge in the Computer Science discipline through teaching, research, and service (http://www.rowan.edu/colleges/las/departments/computerscience/).

The Computer Science Department at Rowan is typical of many of the departments on campus in which each department is part of a larger college division. The Computer Science Department is part of the College of Liberal Arts & Sciences. The organization of the departments is hierarchical, the college Dean is the central authority of the college and each department has a Chair that reports to the Dean. The faculty and support staff report to the Chair during normal day to day operations. At the department level, the faculty practice their own pedagogy and curriculum with the framework of the mission of the department. There is a central mission of the department and an agreed upon curriculum, but faculty are free to design and deliver the material any way they see fit within the frame of the core mission and guidelines. This is typical of many colleges around the country (Bolman & Deal, 2003).

Rowan University has implemented a summer bridge program as an alternative to the normal admission process that admits students who otherwise might be shut out of a college education because of economic limitations or limited academic preparation. Rowan University's Pre-College Institute (PCI) is comprised of two components, the Educational Opportunity Fund (EOF) for students from low income families and

Maximizing Academic Potential (MAP) for students who failed to meet the minimum entrance requirements, but show academic potential. The students entering Rowan University through the PCI program are evaluated at the end of the summer program by the EOF/MAP staff and are recommended for retention or denial of admission to Rowan University based on the student performance records over the summer program.

The PCI Program at Rowan University prepares students to survive the rigors of college life, but there is still a need to address issues that tend to drive students away from math, science, and engineering majors such as gender and race socialization, a lack of mentors and role models, and poor perceptions of these majors (Beyer, Rynes, Chaves, Hay & Perrault, 2002; Cardinale, 1992). This study attempted to determine if more of this untapped student group could be enticed into computer science by examining their mental models about the major, their preparedness to survive the major, attempting to raise their awareness about the major, and offering an alternative path into the major.

Cycle I

This cycle of the study was essentially a reconnaissance and fact finding mission that defined the needs of underrepresented students in technology literacy and examined current policies and enrollment data for Rowan University. In this cycle, Rowan University enrollment data and policies were gathered from the Institutional Research and Planning Department and from reports generated as part of Rowan University's Middle States review over the period of 2000 to 2007, and analyzed to form a picture of the breakdown by ethnicity and gender of students in the computer science program and to determine whether Rowan University has a plan to address the issues associated with life in a technological society. Examination of current policies and documentation was used to paint a picture of how Rowan University seeks to prepare students for life in a technological society. The policies and documentation used are part of the 2004 Middle States Report that documents the changes that have occurred since Rowan University's accreditation was last reaffirmed in 1994.

Cycle II

Cycle two of this study was to evaluate the mental models of incoming freshmen in the EOF/MAP program during the summer of 2006 and factors that influence their choice of major**.** Mental models are deeply ingrained assumptions, generalizations, or even pictures or images that influence how we understand the world and how we take action (Senge, 1990). By exploring the PCI students' mental models about computer science, this study sought to unearth internal pictures of their understanding of computer science and the impact their mental models have on their choice of major. I gathered information from the students in cognitive, societal, and biological areas in an effort to determine if these areas impact the students' choice of major and develop an understanding of their mental models of computer science. I also gathered data on how well the students were prepared for computer science based on the number of math and computer science course they have taken in high school. The 136 students that were enrolled in the 2006 EOF/MAP cohort were surveyed during their fifth week of program. The students were somewhat acclimated to Rowan University and the majors that are available to them. The survey (Appendix A) sought to determine if the students had chosen a major and what they understood about computer science, as well as demographic information, such as race/ethnicity, gender, parental education, student academic background, and future educational plans. Additionally, the survey attempted to gather perceptions and attitudes toward computer science as a major based upon race and gender socialization using questions formulated as a series of four-point Likert items (Patten, 2001). The cognitive questions on the survey attempted to determine what the students understood or did not understand about computer science and whether they felt prepared to enter the computer science major. The societal questions attempted to determine if race and gender socialization were factors in the students' choice of a major, and the biological questions attempted to ascertain if gender socialization played a factor in their choice of major.

Cycle two of this study was geared towards laying the foundation for the action taken in cycles three and four, to gain a deeper understanding of what it takes to entice students to choose computer science as a major by exploring factors that influence or hinder a students' choice of major. To accomplish this outcome, I believe that understanding the students' mental models allowed me to unearth internal pictures of computer science and bring them to the surface where they could be studied and their thinking could be opened to change (Senge, 1990). Through the data collected in this cycle of the study, I gained a deeper understanding of the effects that societal, biological, and cognitive mental models of computer science have on a students' choice of major, this understanding of the underlying assumptions laid the foundation for the intervention in cycles three and four of this study.

Cycle III

Cycle three of this study was a narrative of the course of action, as documented in my journal and field notes, as I used my leadership to facilitate a collaborative effort to design and lay the groundwork for the pilot of a pipeline that offers an alternate route into the computer science major. As I practiced the tenets of my leadership, I realized that I was in the midst of first order change (Bartunek & Moch, 1987; Bartunek & Moch, 1994) within myself. I realized that the underlying assumptions of my leadership were being challenged. I moved outside of my "comfort zone" during this cycle in order to facilitate a first order change initiative to enroll more underrepresented students in computer science. This realization was caused by a mismatch in my espoused leadership theories and my theories in use. I was working in the double loop or Model II mode of thinking (Argyris, 2001).

As I moved from single loop to double loop thinking and re-evaluated what was driving my leadership, I realized that my passion and my educational philosophy were the forces driving me to seek new paradigms in computer science education. I was gaining a deeper understanding of my Hedgehog Theory (Collins, 2000), which was a deeper understanding of my passions, my leadership, and what was driving me to seek this change. I also learned in this cycle that "bowling alone" (Putnam, 2000) would never lead to the change I sought. I realized that only through a team effort would my change initiative become a reality. This led me to utilize "team learning" and the "dance of change" (Senge, 1990; Senge, 1999) to facilitate the first order change initiative I sought.

Cycle IV

Cycle IV of this study was the culmination and pilot of the collaborative design effort for the computer science pipeline undertaken in cycle III. This cycle consisted of a full description of the pipeline, Facilitating Academic Triumph by Providing an Integrated Pipeline Experience (FATPIPE) which provides an alternate route into the computer science major. This cycle also presents a narrative of the pilot, documented by journal entries and field notes. Additionally, this cycle documents student entries from the Online Journal System (OLJS). OLJS was piloted and used by the PCI program as a means for the participants to journal their experience over the course of the five week summer program. The data obtained from OLJS, for purposes of this study, was a look at the students' mental models as the students engaged in reflective practice over the course of the summer. In addition to having the students reflect upon their experience, an attempt to raise awareness about computer science was explored by introducing the PCI students to the concepts of computer science, a formula for success in the major, and the career possibilities available upon graduating with a degree in computer science.

The computer science pipeline, Facilitating Academic Triumph by Providing an Integrated Pipeline Experience (FATPIPE), was developed as a pilot program that involved a collaborative effort between the PCI Program, Rowan University Admissions, the Career & Academic Planning Center, and the Computer Science Department. This project sought to enhance the diversity, retention, and success of students in undergraduate computer science education at Rowan University. The flight of students from the computer science major will lead to a shortage of graduates able to fulfill roles in industry, education, and research occupations. To address this dilemma, FATPIPE was established to provide opportunities for increased participation of underrepresented students ("Blacks Increasingly Are Moving into the Business Ph.D. Pipeline", 1996; Camp, 1997; Jepson, & Perl, 2002; Kerner, & Vargas, 1994; "Minority Participation in R&D", 1981; Pearl, Pollack, Riskin, Wolf, Thomas, & Wu, 1990; Rodgers & Vargas, 1994), and increased retention and graduation rates. FATPIPE provides early intervention in the form of a Computer Science Alternate Route (CSAR) and a computer science learning community, Learning in Bits and Bytes (LiBBy). The CSAR provides an alternate path into the computer science major for students that fall slightly below the entrance requirements. LiBBy provides a support infrastructure to increase the success, retention, and graduation rates of computer science majors.

Overall, FATPIPE addresses the factors that drive underrepresented students away from the computer science major majors such as lack of math skills, gender and race socialization, lack of tutors and mentors, and education presented in a context that does not allow these students to construct meaningful learning environments (Croom, 1984; Griffin, 1990; Hill, 1990; Stockard, Klassen, & Akbari, 2005).

Cycle V

The fifth cycle of this study was an exploration of and reflection on my leadership and the application of my leadership during this study. I explored how my espoused theories and theories in use have evolved and been impacted during my studies and over the course of this research and the role it has played in this research. In this cycle I also explored how the mental models of the participants were impacted as the result of reflective practice and the initial interactions I had with them over the course of the study.

The data collected on my leadership in cycle III and IV of the study consisted of entries from my leadership journal and field notes as I practiced and reflected upon my leadership. The data was analyzed in this cycle and served as the basis for a critical examination of my leadership in use as I facilitated the creation and pilot of FATPIPE. The data was entered and stored in an online journaling system, Online Leadership Inventory System (OLIS) Appendix B, which I piloted during this phase of the study. The goal of the OLIS is to document some of the interactions that influence the knowledge, practice, and motivation of my leadership. I completed the logs to capture the nature of interactions I had with my colleagues during this cycle of the study. I also noted what prompted the interaction, who was involved, how it took place, what transpired, the area it pertained to, and any meaningful quotes that were captured. The web pages, shown in Appendix B, were used to enter and store observations and journal entries in a database and web pages were available that allowed me to generated various reports sorted on different criteria.

In addition to the OLIS system, the Online Journaling System (OLJS) system was also developed as part of the work performed with the PCI department. The purpose of the OLJS system (Appendix D) was to capture the participants' thoughts on the interactions with faculty, staff, and peers over the course of summer program. The data served as a gauge of the participants' mental models and the impact the summer experience had upon their mental models.

Conclusion

This mixed mode action research study (Creswell, 1998; Patton, 2002) sought to answer the research questions about the disparity of underrepresented students in math, science, and engineering, with particular focus on computer science. This study culminated in the design and pilot of a computer science pipeline that is a combination of early intervention in math, a learning community, and a mentoring component in an effort to increase enrollment and diversity in computer science at Rowan University. The pipeline design was accomplished by examining mental models or underlying assumptions and attempting to influence or change them. In order to accomplish this change, first and second order change initiatives (Bartunek & Moch, 1987; Bartunek &

Moch, 1994) were sought through reflective practice and team learning. Additionally, my leadership and the role it played were explored as I progressed through the cycles defined above. The overall outcome of this study was to increase enrollment of underrepresented students in computer science through my leadership and to employ reflective practice with a critical examination at how my leadership changed and evolved over the course of this study.

Chapter 5

Cycle I Analysis

"You must be the change you wish to see in the world" - Mahatma Gandhi

Introduction

What is action research? Action research is simply a form of self-reflective inquiry undertaken by participants in social situations in order to improve the rationality and justice of their own practices, their understanding of these practices, and the situations in which the practices are carried out (Kidd & Kral, 2005). As I attempt to understand this definition, I reflect upon its meaning. I could state that action research is the understanding of the practices in a social situation, or does it mean the understanding and rationality of practices in a society?

Edgar H. Schein (1992) explored society from the inside out by looking at the underlying culture in an organization, which is essentially a micro society. Schein explains how to analyze an organization by understanding its culture on the three levels. Schein defined the levels using the analogy of a child and how a child is reared by its parents. A child is taught a set of beliefs, behavior, and values from birth through maturity. As the child goes out into society and interacts with others it evolves through new information learned through these interactions. Schein sees each evolution in an individual's life as a death and rebirth. The central theme is that an organization is like a child, which must be taught as it grows and counseled as it matures and changes to face challenges of a world that is constantly evolving. As a parent I can appreciate how a society is born and grows, just as a child does. As parents we instill in our children a base set of beliefs, behavior and values. From birth they are taught our value system and how to react to stimuli to the base needs and assumptions.

This theory holds true for a society, the children in a society are its citizens and there is a culture in a society based on shared beliefs, behavior, and values. In a society there are also many subcultures due to cultural differences based on ethnicity and socioeconomic backgrounds. Underlying all of these subcultures is a universal culture that allows the society to function as a whole in spite of the diversity of its citizens.

As an educator, my task is ultimately to produce technically literate, productive members of the technological society in which we live. As this society evolves, due to pressures from technology, industry, globalization, and economics, educators and educational paradigms must evolve to ensure that the needs of society and its citizens are met. This leads me to the question of how we improve the education of the citizens in a society? The answer is through action research. We improve the pedagogy and curriculum by studying it, understanding it, and suggesting improvements in a sociocultural context to ensure the needs of a diverse population are met. This is the purpose of this study, to understand and suggest improvements to the education of underrepresented students in a technological society from the standpoint of computer science education at Rowan University.

Organization Characteristics of Study Site

Rowan University is a medium sized university that consists of seven colleges that offer degrees in engineering, liberal arts and sciences, fine and performing arts, education, communication, and business. The current enrollment at Rowan University is approximately 10,000 students. Rowan University is committed to integrating technology into the educational process and in the early 1990's policies were initiated as part of the master plan to ensure technology would play an integral part in Rowan's future.

Current Rowan University Policy

Technology has played an important role in the teaching and learning process at Rowan University for many years. In 1993, $1.8 million of the New Jersey Equipment Leasing Fund was used to significantly upgrade the academic computing student laboratories and campus network. Major efforts to develop computer literacy on the part of the faculty, staff and students were initiated throughout the late 1980s and 1990s. The continued development, from 1984 to the present, of faculty training seminars and workshops and formalized staff training with coverage of computer use in the classroom, and the development of undergraduate Computer Literacy and the undergraduate and graduate Computer Environments courses demonstrate the importance that the faculty and the institution have placed on technological literacy (http://www.rowan.edu/selfstudy).

The Rowan Plan for Life in a Technological Society

One of the seven key elements in the 1995 document Beyond 2000: The Rowan Vision was "Life in a Technological Society." The Vision also discussed "Using Technology" as a necessary factor in achieving the Vision elements. Seven campus planning task forces were charged to consider "Life in a Technological Society: Using Technology" and consisted of members from the campus community, including faculty, professional and administrative staff, and students. The Technology Task Force was organized into six subcommittees: Curriculum and Instruction, Access, Human Interface, Organization, Future Technologies, and Infrastructure. The recommendations of the task force formed the basis of the technology proposals in The Rowan Plan (http://www.rowan.edu/selfstudy/two.html).

The Rowan Plan directs that technology should be viewed as a triangle of concerns: teaching and learning, support, and infrastructure. The successful use of technology in teaching and learning depends on the essential components of support and infrastructure. Support refers to those people and structures that make it possible for students, faculty, and staff to use technology well. Infrastructure refers to the campus data, voice, and video network. The goals of the Teaching and Learning point of the triangle were to assure that technology is available to all faculty, staff, and students. These goals were to be met by policies that assure that all Rowan students, faculty, and staff have access to the technologies they need, and the ability to use them intelligently, in the classroom, the library, throughout the campuses, and at their residences, whether on or off campus. To ensure that all students are adequately prepared to effectively use technology, a computer and technology competency requirement is in place for all students. To provide the infrastructure to support these new technology initiatives, an upgrade of the networking infrastructure was undertaken; smart or technology enhanced classrooms were installed; computer laboratories were upgraded; a new organization, the Division of Information Resources, was formed; and an annual budget was established to accommodate the maintenance and replacement of technology. All of these policies were to provide the support infrastructure for the technology initiatives (http://www.rowan.edu/selfstudy/five.html).

Rowan University is still committed to these ideals as demonstrated by the ground breaking for the Rowan Technology Park on April 10, 2006. In 2001, Rowan University was awarded a grant of $5.8 million by the New Jersey Economic Development Authority to establish the Rowan Technology Park. The goal of the VTP is to lead the economic revitalization of southern New Jersey through an integrated strategy of science and technology initiatives. The mission of the VTP is to: Expand and strengthen the unique research and learning environments of Rowan University, establish a technology-based entrepreneurial economy, and create value for its surrounding communities in their economic, physical and social development (http://www.sjtechpark.com/about/overview). This commitment to Life in a technological society was also evident and recognized at the government level as I listened to a New Jersey Senator during the groundbreaking ceremony.

> I think what is happening today is what we need to replicate in different parts of our country and I'm glad to see that this County is leading the way. Now we need to talk about the challenges in our nation in terms of engineers and scientists and the fact that we actually import people into this country in order to meet our domestic needs here at home. I dream of a nation where we fuel that need right here and have the human capital at home that will meet our challenges and fuel our competitiveness in the days ahead, and so what Rowan is doing here with the Innovation Center is ultimately driving where the nation has to go in a world that has been transformed by technology in which the boundaries of mankind have largely been erased by virtue of that technological revolution (http://www.rowan.edu/it/cc/news.htm).

What this indicates is Rowan's commitment to technological literacy, but where does this leave underrepresented students? Unless initiatives are also instituted to ensure they move forward as Rowan and the rest of the world moves forward, they will be ill prepared to survive and thrive in a technological society.

Enrollment at Rowan University

Looking at the enrollment data for Rowan University allowed me to construct a picture of the student population based on ethnicity and sex of the students who have chosen computer science as their major. The data was gathered from the Office of Institutional Research and Planning (IRP) at Rowan University. The mission of the IRP is to provide the university administration and community with information useful in assessing the present and planning for the future. In addition, Institutional Research often provides general information about the college and its environment and provides a comprehensive view of the institution and its programs. Such basic information is helpful in providing better service to the students. The Office of Institutional Research and Planning also interacts with the State and Federal agencies as well as many national organizations which collect data concerning higher education in America (http://www.rowan.edu/open/irp).

I examined enrollment data for the period between 2000 and 2006. The data showed that the diversity of the Rowan University student population has changed only 2% during this period. In 2000 students who were non-White totaled 18.57% of the population and in 2006 that figure rose by roughly 2% to 20.45% of the total student body. Table 1 and figure 7 illustrate the gender and ethnic breakdown of the students during the periods I examined. The data also indicated that total enrollment at Rowan University has risen 4% over the period examined and that White students, both male and female, comprised the majority of the student population. When the data was examined in terms of gender, the total enrollment over the period examined showed a 3% drop in female enrollment and a 2% increase in male enrollment.

Table 1

Total University Enrollment by Ethnicity and Gender

Year	Unknown	Black	Amer Indian	Asian	Hispanic	White	Female	Male	Total
2000	114	860	37	332	446	7575	5634	3730	9364
2001	203	914	38	311	499	7823	5929	3859	9788
2002	305	898	38	284	483	7677	5838	3847	9685
2003	340	861	29	290	494	7653	5702	3965	9667
2004	252	877	32	315	547	7665	5622	4066	9688
2005	204	871	35	292	595	7765	5593	4170	9763
2006	252	847	39	287	638	7515	5354	4209	9578

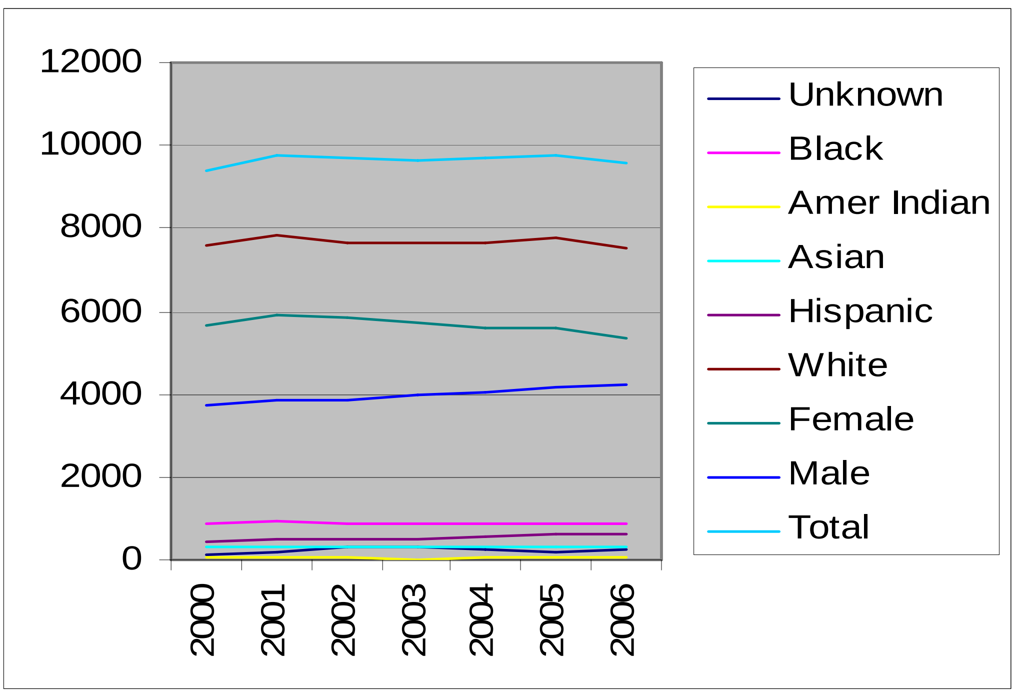

Figure 7. Total University Enrollment by Ethnicity and Gender.

Over the same period, enrollment in computer science indicated that there has been a downward trend in students choosing computer science as their major. Total enrollment had dropped 39% over the period examined. During this same period the number of underrepresented students has declined also. Non white students were 29% of the computers science majors in 2000 and declined to 21% of the computer science majors in 2006. Additionally, the female population, exclusive of ethnicity, of the computer science major declined from 23% to 5% over the same period. The enrollment in computer science is illustrated in table 2 and figure 8.

Table 2

Total Computer Science Enrollment by Ethnicity and Gender

Year	Unknown	Black	Amer Indian	Asian	Hispanic	White	Male	Female	Total
2000	5	28	0	50	24	259	280	86	366
2001	3	29	0	38	18	247	264	73	337
2002	5	20	3	23	16	237	222	54	276
2003	2	19	2	22	8	166	184	35	219
2004	2	17	1	18	15	151	185	19	204
2005	1	11	1	9	9	113	136	8	144
2006	2	12	2	9	9	117	146	5	151

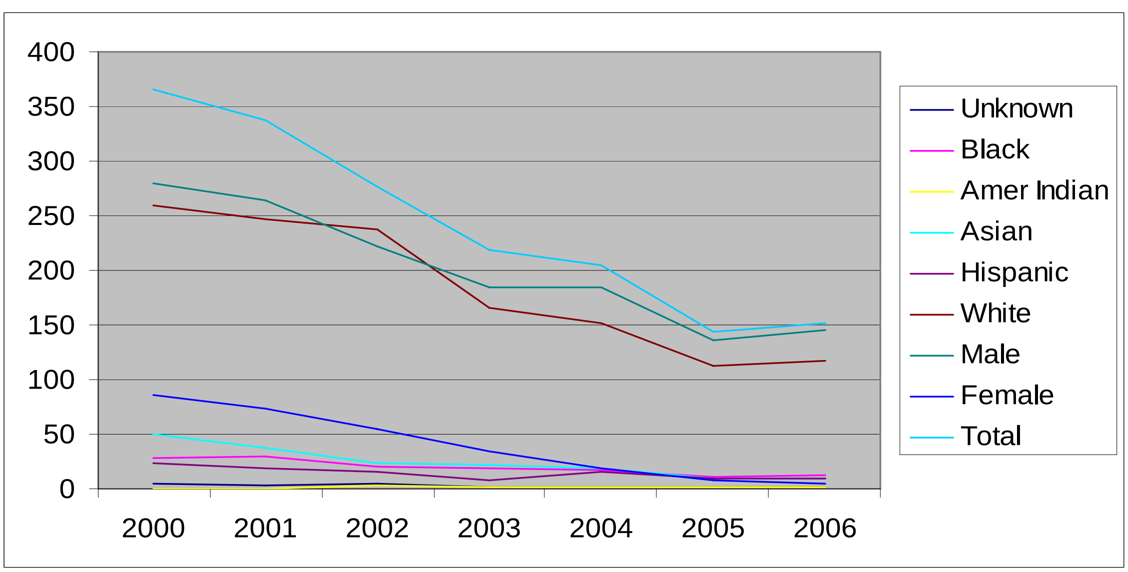

Figure 8. Total Computer Science Enrollment by Ethnicity and Gender.

Rowan University is sensitive to diversity issues and published a special research brief in May of 2003 (http://www.rowan.edu/open/irp/ResBriefs/RBEthnic.pdf). This publication provided data that outlined how Rowan University faired in benchmarks that measure ethnic diversity over the period from 1990 to 2003. The data covered the following benchmarks:

- The proportion of minority students among the matriculated undergraduate population.
- First-to-second year retention rates for all first-time full-time freshmen.
- Six-year graduation rates for native students.
- The proportion of minority students earning a baccalaureate degree.
- Minority enrollment at Rowan as a representation of the proportion of the minority population living in the seven-county SJ marketing area.

The data shown in table 3 and figure 9 shows that the proportion of minority students among matriculated undergraduates has increased from 16.1 percent in 1990 to 18.8 percent in 2002, during the same period; total enrollment increased approximately 17%.

Table 3

Matriculated Undergraduate Headcount by Ethnic Category

Year	Minority	Majority	Total
1990	16.1	83.9	6615
1991	16.6	83.4	6743
1992	17.2	82.8	6864
1993	17.8	82.2	6640
1994	19.1	80.9	6380
1995	19.4	80.6	6505
1996	18.3	81.7	6947
1997	18.3	81.7	7171
1998	18.1	81.8	7424
1999	17.7	82.3	7676
2000	18.8	81.2	7382
2001	19.0	81.0	7706
2002	18.8	81.2	7737

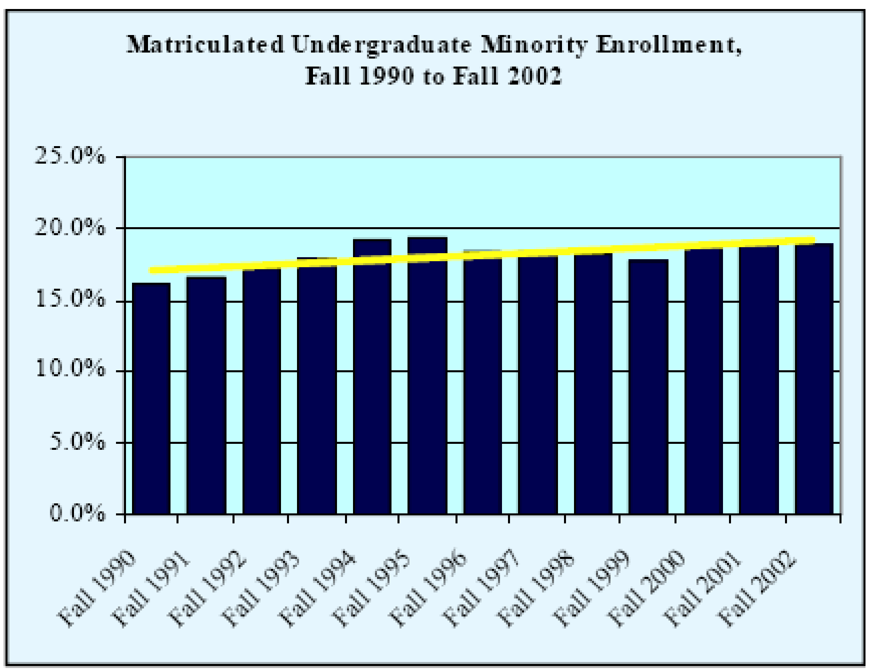

Figure 9. Minority Enrollment at Rowan University from 1990 to 2002.

In 1990, the majority of the undergraduate population was White when compared to the population of seven counties in southern New Jersey. The counties are those that surround Rowan University, Atlantic, Burlington, Camden, Gloucester, Salem, Cape May, and Cumberland counties. The enrolled White population was slightly higher that the White population of the seven counties. The students enrolled at Rowan University were more representative of the population of the seven southern Jersey counties in 2002. This data is shown in figures 10 and 11. Additionally, Black and Asian undergraduates at Rowan exceeded the number of these ethnicities in the population of the seven southern New Jersey counties.

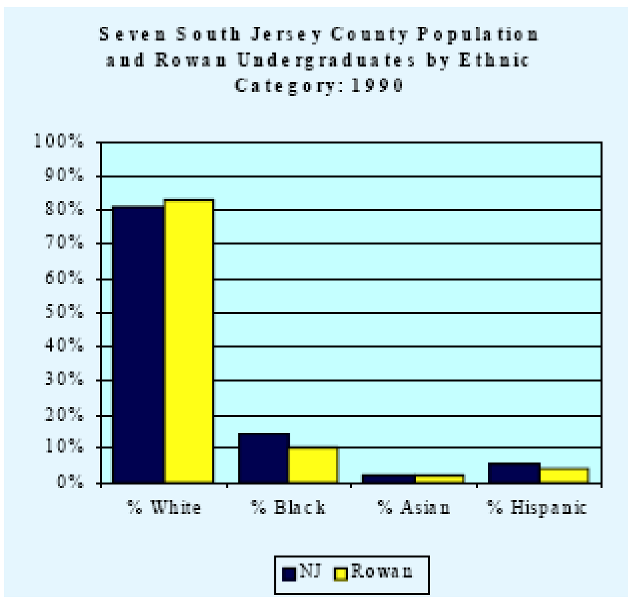

Figure 10. 1990 Minority Enrollment at Rowan University.

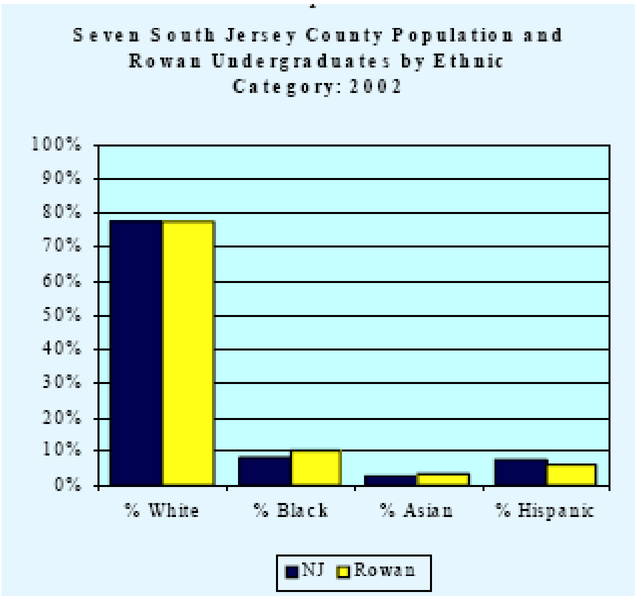

Figure 11. 2002 Minority Enrollment at Rowan University.

In 1990, retention rates for minority students returning for their second year were slightly less than that of the white students. The retention rates were 72.4% for Black students, 61.3% for Hispanic students, 73.9% for Asian students, and 79.3% for White students. In 2001, the retention rates for minority students returning for their second year increased to 89.7% for Black students, 76.9% for Hispanic students, and 70.8% for Asian students, compared to 83.8% for White students. The retention rates marked an increase for all groups except Asian students, this was due in part to fewer than 50 Asian students being enrolled. The retention data is illustrated in figure 12.

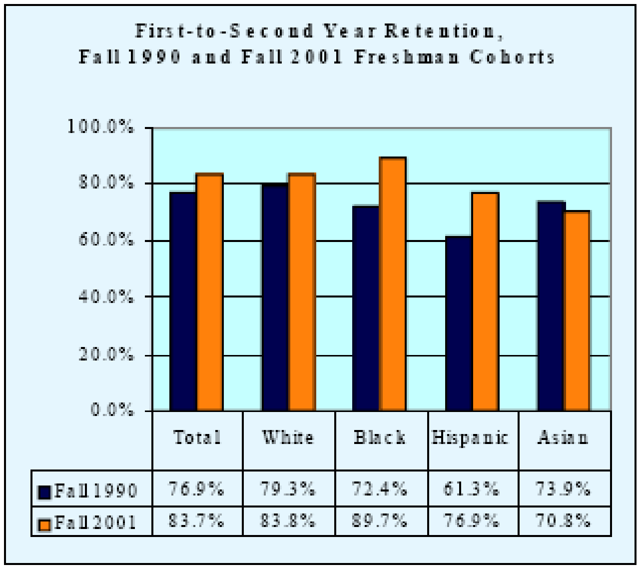

Figure 12. Rowan University Retention Rates from 1990 to 2001.

In addition to an increase in retention rates for minority students, there was also a marked increase in the graduation rates for these students during the six year period between 1990 and 1996; this is the period that the six year graduation rates were tracked for the 1990 cohort. In 1990 the graduation rates were 29.3% for Black students, 33.9% for Hispanic students, 13.0% for Asian students, and 55.8% for White students. The graduation rates in 1996 had improved significantly from 1990; the rates increased to 50.6% for Black students, 49.3% for Hispanic students, 55.2% for Asian students, and 65.8% for white students. The data is shown in figure 13.

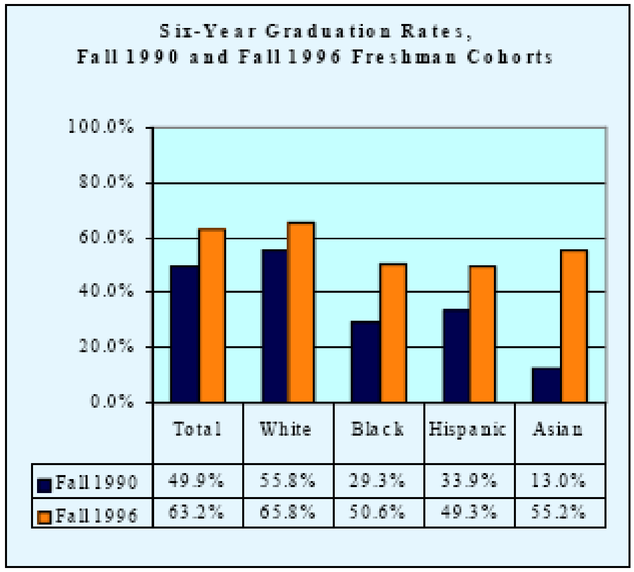

Figure 13. Rowan University Graduation Rates from 1990 to 1996.

With the increases in retention and graduation rates at Rowan University, there was an increase in minority students receiving Bachelor's Degrees over the period from 1993 to 2002, as illustrated in figure 14 and table 4. The total degrees awarded increased 15% over this period, in 1993 minorities received 12% of the degrees awarded and increased to 15.5% in 2002.

Table 4

Bachelor Degrees Awarded from 1993 to 2002

Year	Minorities	Percent of Total	Total
1993	175	12.0	1459
1994	194	12.6	1459
1995	182	12.3	1539
1996	184	13.2	1481
1997	199	14.7	1397
1998	227	16.5	1353
1999	220	15.6	1387
2000	243	14.4	1411
2001	255	15.6	1691
2002	261	15.5	1632

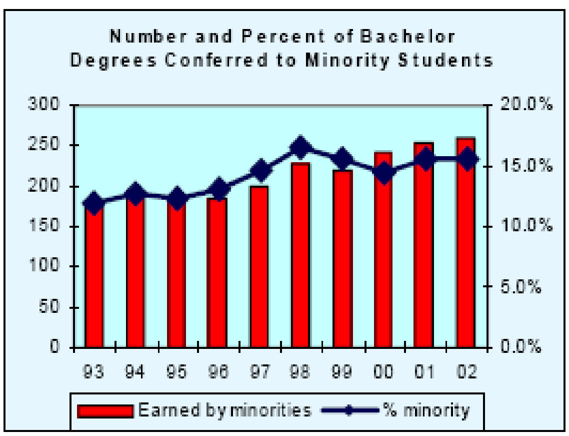

Figure 14. Bachelor Degrees Awarded to Minorities at Rowan University.

Discussion

The Plight of Underrepresented Students

The enrollment data for Rowan University indicated a slight increase in total enrollment over the period from 2000 thru 2006. During this period, there was a drop in female enrollment and a small increase in the male population of the enrolled students and the percentage of the non White students remained relatively constant over the same period. This data indicates that underrepresented students choose other colleges, do not attend college, fail to meet the entrance requirements, or that Rowan University has done little to actively recruit underrepresented students.

The diversity data over the period from 1990 to 2002 indicated an increase in total enrollment, as well as an increase in minority enrollment. Over this same period there were increases in retention, graduation, and degrees awarded to minority students. During this period Rowan University experienced significant growth in the student population, but the period following 2002 that was examined indicated that overall enrollment for all groups leveling off.

During both periods, enrollment in computer science displayed a marked downward trend for both White and non-White students and additionally, a significant decrease in female students choosing this as a major. The examination of the student population enrolled in computer science, over the later period, indicated alarming trends in students who chose computer science as a major. The first trend that appeared from the data was a major drop in overall enrollment in computer science. The non-White students who choose computer science as a major remained relatively constant over the period examined, but the female population indicated a major decrease in females that choose computer science as a major. This is indicative of what was found in the literature, the flight of underrepresented students from math, science, and engineering majors.

The trends that emerged from examining the enrollment data at Rowan University in the context of race and ethnicity indicated that this population of students enrolling in Rowan University showed a large decrease in the female population choosing computer science, even though they make up the largest percentage of students. This trend follows worldwide trends showing women in general shying away from math, science, and engineering disciplines making them more at risk than minority students, requiring greater efforts to entice them into these fields, as well as increased activities to attract minorities as well if they are to be equipped to survive life in a technological society.

Now that I understand the plight of the underrepresented students, the question that comes to mind is, "What can be done to address this problem?" The literature has shown that intervention programs have helped underrepresented students survive the rigors of college life, improve retention rates, and improve graduation rates, but this does not fully take into account the technological society we live in today. Within this context, I feel that in addition to preparing underrepresented students to survive and be successful in college, we must also entice more of them to choose math, science, and engineering majors to prepare them to survive and be successful in a technological society as well.

As an educator teaching computer science, I feel obligated to prepare not only underrepresented students, but all students to be technologically literate. The downward trend in computer science enrollment indicates that students from all groups are shying away from this major for other majors. With fewer students in the pipeline, there will be fewer students to fulfill the roles of educators, researchers, workers, mentors, and role models in the future. In light of the findings from this cycle, my task as an educator is clear. First I must entice more students to choose computer science as a major, and secondly, I must prepare them to be technologically literate. The first task can be addressed based upon the success of cycle IV of this study to entice more underrepresented students into the computer science major. The second task involves structuring the proposed computer science awareness raising seminars to ensure that students are introduced to computer science education in a sociocultural context that allows students to construct meaningful knowledge and to overcome race and gender threats that drive students away from the computer science major.

Chapter 6

Cycle II Analysis

> The shape of our lives is defined by our insertion into institutions and systems whose interlocking power generates the "virtual reality" we experience. Such 'knowledge' is so thoroughly a part of our worldview that it simply would not occur to most people to question it. Yet underneath this reality is another, subinstitutional reality in which very different responses are simply acted out. This is the reality in which everyone, until very recently, lived. - David Schwartz

Introduction

This cycle was designed to analyze the mental models of students in the Rowan University's Pre-College Institute (PCI) on factors that influence/hinder their choice of major. Mental models are representations of reality that people use to understand specific phenomena. Mental models form the framework for the cognitive processes of our mind, which allows one to develop an understanding of their lives and the world around them. Each individual's picture of the world is different to the point that two people can observe the same things and describe it differently. Mental models are subtle but powerful. Mental models are subtle, because we usually are unaware of their effect on our perceptions. Mental models are powerful, because they determine what we pay attention to, and therefore what we do. Mental models are strongly conservative and unless they are challenged, they will cause us to see what we have always seen, the same needs, the same opportunities, the same results. And because we see what our mental models permit us to see, we do what our mental models permit us to do (Senge, 1990).

The factors that were explored, in this cycle, focused on socialization factors, mental models, and understanding of the computer science major and the role each played in a students' selection of major. The socialization areas that were explored in this cycle of the study were what influence societal and biological socialization had on the participants perceptions about computer science. Additionally, in order to better understand what the students understood about computers and the computer science major, the students' cognitive mental models of computer science were ascertained. A survey was given in the summer 2006 that gathered demographic information from each student along with their societal, cognitive, and biological mental models about computers and the computer science major. The students that participated in this study were incoming freshmen in Rowan University's PCI Program.

The PCI Program is a summer bridge program that was created to give disadvantaged students the opportunity to experience campus life, improve academic skills, work with faculty members, and receive career-counseling services prior to entering college in the freshmen year. The predominate feature of the PCI program is a disciplined approach to teaching the survival skills necessary to succeed in college. Participants have the opportunity to earn college credits during the summer programs by participating in course work, structured study periods, group discussions, and other activities that promote academic and personal success. The overall goal of summer bridge programs is to better prepare disadvantaged students academically to face the rigors of college level coursework and to help them to adjust to the college environment. These factors in turn increase the retention and graduation rates of disadvantaged students

(Ackerman, 1991a; Ackerman, 1991b; Ami, 2001; Buck, 1985; Evans, 1999; Fitts, 1989; Garcia, 1991; Suhr, 1980).

Respondents

Respondents from the PCI program had been exposed to five full weeks of the program at the time the survey was distributed in the summer of 2006. All students were incoming freshmen to Rowan University in southern, New Jersey. The survey was distributed directly to the 136 participants in the PCI program, resulting in a 93% response rate. Both males and females took part in the program, with the majority of the students being African American/Black and Hispanic/Latino.

The Survey

The survey (Appendix A) was a compilation of questions formulated to assess the mental models of the PCI students on factors that influence their choice of major and their mental models of the computer science major. The close-ended survey was reviewed with my dissertation committee and feedback was used to improve survey items before administration. The first part of the survey collected demographic information, using items such as race/ethnicity, sex, parental education, student academic backgrounds, future educational plans, and what major, if any, the students had decided to pursue. The second part of the survey was a formative evaluation composed of statements, formulated as a series of four-point Likert items (Patten, 2001). Each item inquired about societal, cognitive, and biological areas in relation to computer science education, requiring the respondent to choose his/her level of agreement with the statement. The purpose of these items was to gather the students' mental models on computer science and factors that influenced or hindered their choice of major at Rowan

University. In order to ensure accurate mental models were obtained in the areas of interest, the four point Likert scale was chosen. This eliminated the “undecided” or “neutral” response, which would not allow the compilation of a true representation of a respondent’s mental model.

Procedure

The supervisor of the PCI program was contacted, asked for permission to give the survey, and advised of the purpose of the study. I met with the PCI students on August 8, 2006, during a scheduled, required meeting at Rowan University. Instructions were given to the PCI students prior to the administration of the survey. Students then completed the six page surveys; after completion and before submitting them, prizes (USB Jump Drives) were raffled off to thank the students for participating in the study. The raffle consisted of numbers pulled from a box that represented the survey number that each respondent was randomly given. After all the prizes had been awarded, the students submitted the surveys. Data from the 127 surveys were entered into the SPSS program, a computer software program that sorts, groups, and gives statistical information using the entered data.

Results

This study was designed to identify students’ mental models of computer science, their high school preparation in math and computer science, and mental models based on societal and biological socialization factors. The participants were incoming freshmen participating in Rowan University’s PCI summer bridge program, known as the EOF/MAP program.

Demographics

Demographic information obtained about respondents revealed that of the 127 students participating in either program, 43.3% were male and 56.7% were female. The EOF program had 88 total participants, of which 51 were male and 37 were female, the MAP program had 39 total participants, of which 16 were male and 23 were female. Both programs had a total ethnic breakdown that consisted of African American/Black, Hispanic/Latino, White/Caucasian, Asian American/Pacific Islanders, and American Indian/Native American (Tables 5 and 6).

According to survey results, the Hispanic/Latino and African American/Black population had higher program participation rates compared to the participation rates for all other races. Table 5 shows the demographic breakdown of each program by sex and table 6 shows the demographic breakdown of each program by ethnicity.

Table 5

Demographic Breakdown by Sex

	Male	Female	Total
EOF	58.2%	77.8%	88
MAP	41.8%	22.2%	39
TOTAL	55	72	127

Table 6

Demographic Breakdown by Ethnicity

	African American/Black	American Indian/Native American	Asian American/ Pacific Islander	Hispanic/ Latino(a)	White/Caucasian	Multi Racial	Total
EOF	50.0%	0%	3.41%	31.82%	13.64%	1.1%	88
MAP	33.3%	10.26%	15.39%	35.9%	2.56%	2.56%	39
TOTAL	57	4	9	42	13	2	127

High School Preparation

There were two survey questions that gathered information related to the participants' high school preparation in math and computer science. The students' responses were obtained by survey questions that asked how many math and computer science courses were taken in high school. The survey results indicated that the majority of the participants in the PCI program had taken 1-3 computer science courses and that 36% of the students had taken math up to pre calculus in high school. The survey results are shown in table 7 and table 8.

Table 7

CS Courses Taken in High School

	None	1-3	4-6	7-10	10 or More	Total
EOF	30.68%	54.55%	11.36%	2.27%	1.14%	88
MAP	25.0%	61.11%	13.89%	0%	0%	36
TOTAL	36	70	15	2	1	124

Table 8

Math Courses Taken in High School

	Pre Algebra	Algebra	Geometry	Algebra II	Pre-Calculus	Calculus
Yes	48.0%	86.6%	85.8%	81.1%	36.2%	9.4%
No	52.0%	13.4%	14.2%	18.9%	63.8%	90.6%

Mental Models

Students' mental models of the computer science major were ascertained by survey questions on what they understood about the computer science major and how prepared they felt they were to enter the major. Students indicated their level of agreement or disagreement with ten statements related to the computer science major, using a 4-point Likert scale. Table 9 displays the statements and student responses by giving the percentage of students who responded to the statements for each Likert scale (1=Strongly Disagree, 2=Disagree, 3=Agree, and 4=Strongly Agree). The survey results indicated that overall, the majority of the participants the PCI programs felt they had a strong math background, liked using logic to solve problems, had a strong computer background, had used computer prior to high school, and felt they could succeed in computer science. Surprisingly, 41% of the respondents felt they did not understand what a computer scientist does and 59.1% of the students had not thought about computer science as a major. Additionally, 36.8% of the respondents felt they were not prepared to handle the college curriculum.

Students' mental models of the effects of societal factors on their perception of the computer science major was ascertained by survey questions on what they thought about the computer science major and how these perceptions related to race, peers, and future career possibilities. Students indicated their level of agreement or disagreement with nine statements related to the computer science major, using a 4-point Likert scale. Table 10 displays the statements and student responses by giving the percentage of students who responded to the statements for each Likert scale (1=Strongly Disagree, 2=Disagree, 5=Agree, and 5=Strongly Agree). The survey results indicated that the participants of the Rowan University PCI program felt that they would need computer skills to succeed, and that a computer scientist could get a job other than programming, but that computer scientist spend most of their time working with machines instead of people. In the area of ethnicity and gender, the majority of the respondents felt that minorities and women could succeed in computer science. The majority of the respondents also felt that computer science was not only for White males, but that very few minority and women role models are available to inspire them. Finally, in the area of choosing computer science as a major and the impact it will have on relationships with friends and peers, the majority of the respondents felt that computer science majors have no social life, their friends choose majors other than computer science, but that computer science majors can fit in with students from other majors.

Students' mental models of the effects of biological factors on their perception of the computer science major was ascertained by survey questions on what they thought about the computer science major and these perceptions related to gender socialization. Students indicated their level of agreement or disagreement with ten statements related to the computer science major, using a 4-point Likert scale. Table 11 displays the statements and student responses by giving the percentage of students who responded to the statements for each Likert scale (1=Strongly Disagree, 2=Disagree, 5=Agree, and 5=Strongly Agree). The results of the survey in the area of biological socialization indicated that the majority of the respondents were not encouraged to learn computer science, but they wish they had learned more about computers and computer science in high school. Additionally, the result revealed that the majority of the respondents were interested in computer science, and that they were confident in their ability to work with computers. The survey results showed that in the area of biological socialization, the majority of the respondents felt that females could succeed in a major that involves math, and that it is acceptable for women to choose computer science as their major. The majority of the respondents felt that males do not have to choose a major involving math and science, and that their parents would support computer science as a major.

Table 9

Students' Cognitive Mental Model of Computer Science

Survey Question	Strongly Disagree	Disagree	Agree	Strongly Agree
I have a strong math background	20.5%	29.1%	33.1%	17.3%
I like using logic to solve problems	2.4%	11.8%	70.1%	15.0%
Computer science is not for me because I do not have a strong math background	20.5%	41.7%	20.5%	15.7%
I understand what computer scientists do	21.3%	40.9%	32.3%	5.5%
I have thought about computer science as a major	59.1%	25.2%	11.0%	4.7%
The first time I used a computer was in high school	79.5%	16.5%	2.4%	1.6%
I think computers make life easier	2.4%	7.1%	44.9%	45.7%
I feel that I am academically prepared to handle the college curriculum	30.4%	36.8%	27.2%	5.6%
I feel that I have a strong computer background	0%	7.1%	56.7%	36.2%

Table 10

Students' Societal Mental Model of Computer Science

Survey Question	Strongly Disagree	Disagree	Agree	Strongly Agree
I will need computer skills for my job/career after college.	7.1%	13.4%	46.5%	33.1%
Minorities and women are equipped to succeed in computer science and math.	4.8%	26.6%	42.7%	25.8%
Computer science majors have a social life.	2.4%	19.0%	65.9%	12.7%
Computer science is only for white males.	81.1%	12.6%	3.9%	2.4%
Most of my friends choose majors other than computer science.	4.0%	13.5%	48.4%	34.1%
Computer science majors fit in with other non computer science majors.	3.2%	34.4%	56.8%	8.8%
I see very few minorities and women on science channels like The Discovery Channel.	8.9%	24.2%	56.5%	10.5%
Computer scientists work with machines instead of working with people.	6.3%	39.7%	47.6%	6.3%
A computer science graduate can only get a job as a word processor or programmer.	47.2%	42.9%	7.1%	2.4%

Table 11

Students' Biological Mental Model of Computer Science

Survey Question	Strongly Disagree	Disagree	Agree	Strongly Agree
I was encouraged to learn computer science	16.0%	44.0%	26.4%	13.6%
I never had an interest is computer science	21.6%	33.6%	27.2%	17.6%
I spend more time talking to people on computers than in person	26.4%	48.8%	20.0%	4.8%
I am confident in my ability to work with computers	.8%	12.1%	64.5%	22.6%
I wish I had learned more about computers in high school.	6.4%	23.2%	45.6%	24.8%
If I choose computer science as a major I will no longer fit in with my friends.	56.5%	37.1%	3.2%	3.2%
I think females would succeed in a major that involves science or math.	8.8%	18.4%	40.8%	32.0%
I think males should choose a major that involves math or science.	27.2%	41.6%	22.4%	8.8%
My parents do not want me to choose computer science as my major.	56.0%	32.8%	6.4%	4.8%
It is ok for women to choose computer science as a major.	3.2%	6.4%	32.8%	67.2%

Additional Data

Other important results of the survey centered on demographic data and choice of major. A survey question asked students with whom they lived. Survey findings revealed that 32.3% of the students lived with both parents, while 47.2% lived with one parent and 5.5% lived with a grandparent or other relative, or guardian. The results of this survey question are displayed in Figure 15.

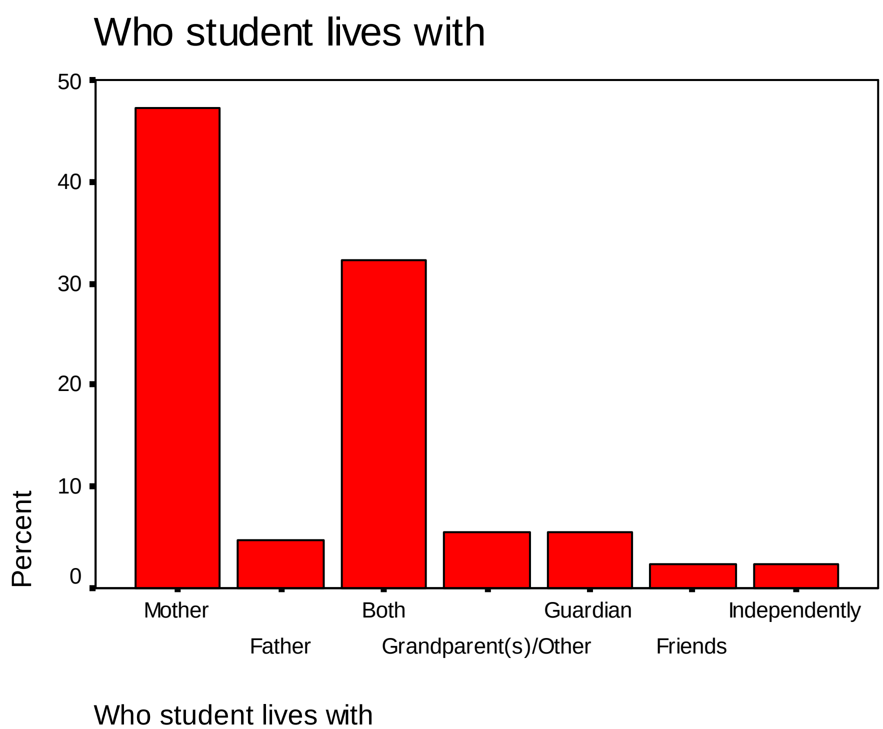

Figure 15. Who Students Live With.

When asked about their parents' education levels, the survey results indicated that 4.7% did not know their mother's level of education and 3.1% did not know their father's education level. The education levels of mothers and fathers ranged from elementary to an advanced degree (Dr., Lawyer, or PhD/EdD). The majority of their mothers (66.9%) and fathers (60.1%) had a high school diploma or less. The remaining distribution of the students' parents had education levels ranging from some college up to an advanced degree. Table 12 summarizes the finding for the education level of the students' parents.

Table 12

Participants' Combined Parents Education Level

Education Level	Frequency	Percent
unknown	6	4.7
elementary	20	15.7
some hs	40	31.5
High School Dipl.	19	15.0
Some College	11	8.7
Assoc. Degree	17	13.4
Bachelor's Degree	6	4.7
Masters Degree	2	1.6
Advanced Degree	6	4.7
Total	127	100.0

Two survey questions were related to the participants' choice of major. The results showed that the majority of the students participating in the PCI programs have chosen a major. Education, law/justice, biology, business, and sociology were the majors chosen by most of the students that had selected a major. Of the students that had chosen a major, only four selected computer science. The survey results are shown in Table 13.

Table 13

Students' Major Selection

Major	N	Percent
Accounting	3	2.4
Advertising	1	.8
Bio Chemistry	3	2.4
Biological Science	8	6.3
Biology	5	3.9
Business	5	3.9
Business Admin	1	.8
Business Mgt	1	.8
Chem Eng	1	.8
Civil Eng	1	.8
Communication	8	6.2
Computer Science	4	3.1
Criminal Justice	1	.8
ECE	4	3.1
Education	7	5.5
Education/History	1	.8
English	1	.8
Env Eng	1	.8
Finance	2	1.6
Health Science	2	1.6
History	1	.8
Industrial Engineering	1	.8
Journalism	2	1.6
Law/Justice	13	10.2
Management	1	.8
Math	1	.8
Math/Ed	1	.8
Mech eng	2	1.6
Music	1	.8
Performing Arts	1	.8
Phychology	1	.8
Phys. Ed	1	.8
Political Science	4	3.1
Pre-med	1	.8
Psychology	4	3.2
Public Relations	2	1.6
Sanitation	1	.8
Sociology	10	7.9
Special Ed	1	.8
Sports Med	1	.8
Total	127	100.0

Discussion

Mental Models and Selection of a Major

> "Mental models are deeply held internal images of how the world works, images that limit us to familiar ways of thinking and acting. Very often, we are not consciously aware of our mental models or the effects they have on our behavior" (Senge, 1990, pg.8)

What factors influence/hinder a students' choice of major? Students have many mental models. In choosing a major, mental models are likely to be built around the socialization a student experienced and their understanding of a major. Mental models are subtle but powerful, because we usually are unaware of their effect, and because they determine how we understand the world and the decisions we make. If mental models are left unchallenged, they will cause us to see the same needs, the same opportunities, and make the same decisions. This is because we see and understand the world through the lens of our mental models and we make decisions based on what our mental models permit us to do. Choices in life must, at some point, expose and challenge the mental models. This does not mean that all mental models will be changed by exposing and challenging them. Many of our mental models, once exposed, will be recognized as the essence of our organization. But some of our mental models will have to change before we can change our future (Senge, 1990; Senge, 1999).

Change in one's mental models is considered first order change. First order change occurs when our mental models are exposed and challenged, causing them to shift an attitude, belief, value, or behavior, and oppose them. The pitfall of first order change is that it can be a temporary change. A common example of first order change is something that is done to temporarily satisfy some inner need, but the need itself is not exposed and changed. Exposing and changing the underlying assumption leads to second order change. Second order change is a shift in basic attitudes and priorities that cause permanent changes in mental models and the decision making process (Bartenuk, 1987; Brickner, 1995).

In this context, underrepresented students have developed mental models that guide the decisions they make, including choice of major. The way a student was socialized in terms of gender, race, and in relation to others in society determines how they see, understand, and decide upon different majors when entering college. These are the factors that influence/hinder a students' choice of major.

Mental Models and the Flight from Computer Science

The EOF/MAP program is designed to provide low income and underrepresented students the opportunity to attend college and to improve their chances for success and graduation by providing financial and academic support (Chaney, Muraskin, Cahalan, & Goodwin, 1998; Garcia, 1991; Laguardia, 1998; McElroy & Armesto, 1998). These programs do not really address the issue of selecting a major, but focus more on surviving the rigors of college life. In order to address this issue, we must expose, understand, and change the students' mental models of the majors available to them.

The first challenge is evaluating the students' mental models of the majors they perceive themselves being prepared to pursue. The findings of the study showed that the majority of the students are mathematically prepared to succeed in computer science based upon the math courses taken in high school. The majority of the students participating in the programs had taken math courses up to pre-calculus. This, however, is not a reflection of their SAT scores (Table 14); entrance into the computer science major for incoming freshmen requires a 540 or better score on the math component of the SAT, nor did the survey results indicate the math courses taken in high school were successfully completed. Students in the MAP program enter the university by this route because they did not receive sufficient SAT scores to meet the minimum requirements for Rowan University. Students in the EOF program use this alternate route because of financial need, which could be coupled with low SAT scores. In either case, the EOF/MAP participants represent an untapped pool of underrepresented students with the potential to succeed in computer science. Additionally, the mental model of the students in preparedness to succeed in this major was positive, but some thought process limited the selection of computer science to a mere four students out of 127 that participated in the survey. This is possibly due to the fact that the majority of the students indicated a general lack of understanding of the computer science major.

Table 14

Fall 2006 Average SAT Scores

Admit	Number	Verbal SAT	Math SAT	HS Rank
Regular	965	563	589	77
Special	96	448	466	57
EOF	119	392	394	55
MAP	42	441	452	65
TOTAL	1232	533	556	73

The next challenge was evaluating the students' mental models based upon societal and biological socialization. The survey results in the area of biological socialization indicated that the majority of the respondents had no major barriers that caused them to look at computer science as a male dominated major, and that either males or females could succeed in the major.

The survey results revealed that societal socialization presented few major barriers to choosing computer science as a major. The students demonstrated some understanding of computer science career opportunities and felt positively that success was possible in the field regardless of race or gender. Additionally, the majority of the respondents felt that computer science majors can fit in with students from other majors. The negative findings indicated that the students felt they would be isolated. The majority of the students agreed that computer scientists spend most of their time working with machines instead of people and that computer science majors have no social life. The respondents also felt that their friends would choose majors other than computer science. Additionally, the majority of the students felt that there was a lack of minority and women role models available in this field, pointing to a possible worry of race or gender isolation. These findings indicated that the majority of the students may have negative perceptions of computer science in terms of race and gender due to the lack of role models and mentors, and isolation from friends and peers stemming from perceptions of the nature of the computer science major, but overall see computer science as providing needed skills and positive career outlooks.

Conclusion

This cycle of the study discovered that there are assumptions in the students' mental models that play a large part in their decision making process when choosing a major. The analysis revealed a general lack of understanding about the computer science major and possible apprehension of ethnic, gender, and social isolation. This was reflected in the decisions of the students regarding which major to pursue. The majority chose majors that involved a great deal of social interaction and diversity. What these findings indicated is a flight of underrepresented students from computer science. The issues that must be overcome to address this problem are providing students with the means of understanding computer science and providing more mentors and role models in the field. The latter cannot be accomplished without enticing more underrepresented students to choose computer science as a major. These groups must be provided with the information and skills to succeed in science, math, and engineering education in order to keep pace with life in a technological society. Providing underrepresented groups the means to decide to pursue degrees in math, science, and engineering, equips them with the ability to become future workers, educators, and scientists who will add much needed diversity to these professions.

Factors that shape women and minority students' mental models when deciding to pursue math and science majors in higher education, such as poor preparation, limited access to resources, gender and race socialization, lack of confidence, and a lack of mentors (Beyer, Rynes, Chaves, Hay & Perrault, 2002; Cardinale, 1992) were evident based upon the findings of this cycle. Underrepresented groups typically are not sufficiently prepared to pursue math and science degrees because of poor math skills and limited computer use. Female perceptions and attitudes toward mathematics and computer use differ from those of males and leads to avoidance of mathematics and computers (Kramer & Lehman, 1990). Females also tend to see mathematics and computer science as male dominated fields and feel that excelling in these fields tends to bring their femininity into question (Durndell, Siann & Glissov, 1990; Schubert, 1986).

Other factors that influence the majors females choose include when they first used computers, their parent's occupations, and the influence of teachers, role models, and mentors (Turner, Bernt & Pecora, 2002; Ware & Lee, 1988). Minority students must overcome obstacles similar to those faced by female students such as poor perceptions of self, poor aspirations as the result of past race socialization, socioeconomic factors, poor academic preparation, and previous family and schooling experiences (McCormick & Williams, 1974; Thomas, 1985). All of these factors form a social context that influences students' mental models and may impact their choice of major.

The power of social context and its effect on mental models is the power of how the development of perceptions and underlying assumptions is impacted by age, race, and gender socialization. A society is made up of individuals with different beliefs and identities. The individuals in a society interact with each other and develop similar interests and knowledge. Individuals with shared knowledge and interests tend to band together and form groups, and then the groups interact and merge with other groups to form organizations. In the context mental models, these same interactions and creation of groups takes place, but the impact is that the perceptions that form because of these relationships can have a positive or negative impact on the decision making framework that is developed (Vygotsky, 1978).

Social issues such as age, race, and gender impact the underlying assumptions and perceptions about the world. Age, race, and gender all play a part in how the mental models are impacted because each area has a different set of perceptions and shared knowledge. The age of the individuals in a group determines how preconceived notions about technology use and technology education may impact the level of buy-in or participation that certain individuals or groups are willing to allow. The same can be said for race and gender. In each category there are certain shared beliefs and ideals that the members of a group hold as the basis for their actions and the basis for how they learn and the decisions they make (Garrison & Bromley, 2004).

Another factor that may have an impact on a students' choice of major depends on parental involvement. The findings also showed that the majority of the participants in this study lived with either one or two parents (Figure 15). This demographic information is significant because it indicates that there is some correlation between the students' discussing education with parents about college and their desire to attend college. Zulli, Frierson, & Clayton (1998) also pointed out that if parents become more involved, this increases the chances of the students' success in college. The education level of the students' mothers and fathers also appears to be of significance based upon the findings of the study. Particular attention was given to the African American/Black and Hispanic/Latino population because they were the highest participants in the target population. The results showed that approximately 15% of the sample groups' mothers and fathers had high school diplomas and that 24.4% of the respondents' parents had an associate degree or higher (Table 12). This could be a contributing factor to the high percentage of underrepresented students in the sample population that choose to attend college (Zulli, Frierson, & Clayton, 1998).

Deciding to attend college does not guarantee success; Perna & Swail (2001) and Perna (2003) attribute many factors to the success and retention of low income and minority students in college. Academic preparation and early intervention are key factors to the success of the students. The findings of the study support these theories based upon the percentage of students that took computer and math classes in high school. Approximately 56% of the participants in the study had taken computer courses in high school and the majority of the students participating in the study had taken algebra I, algebra II, geometry, and pre-calculus. The percentages tend to drop off for advanced math courses (Table 7, Table 8). This could indicate that the percentage of African American/Black, Hispanic/Latino, and female students that are mathematically prepared in advanced math is low due to factors race and income level (Davenport, Davison, Kuang, Ding, Kim & Kwak, 1998).

Good study habits also play a key role in academic success; if the students are learning study habits in high school, they should potentially have higher success rates in college. One of the components of the summer bridge programs is to teach students the study habits they need to survive in college. In addition to study habits, students are acclimated to college life and college course work. Additionally, the students are given an introduction to the support infrastructure that the college provides. This would include services such as tutoring, financial aid assistance and counseling. These experiences have an impact on the graduation and success rates of the participants, but these outcomes are longitudinal and are not measurable without examining students' progress over time (Buck, 1985; Ackerman, 1991a; Ackerman, 1991b; Obler, Francis, & Wishengrad, 1997; Fitts, 1998; Evans, 1999; Ami, 2001).

The overall purpose of this cycle was to examine the mental models of students entering Rowan University through the EOF/MAP programs and to determine the impact the participants' perceptions and attitudes had upon their choice of major. To measure the effectiveness of summer bridge programs would require longitudinal studies that looked at the students' academic success, retention rates, and graduation rates (Suhr, 1980; York & Tross, 1994). The findings indicated that the EOF/MAP programs are effective in acclimating the students to college life and introducing them to the essential skills need to succeed in college, but is weak in the areas intervention and remediation when students lack the necessary preparation to enter STEM majors. The FATPIPE program described in the following chapters was designed to address these weaknesses and provide a means for underrepresented students to enter a STEM major along with an infrastructure that is conducive to their success in STEM majors.

Chapter 7

Cycle III

Project FATPIPE

Introduction

This phase of the study was a narrative of the events that occurred as I used my leadership to facilitate a collaborative effort to design and lay the groundwork for the pilot of a pipeline that offers an alternate route into the computer science major. As I practiced the tenets of my leadership, I realized that the underlying assumptions of my leadership were being challenged and I was forced to move outside of my "comfort zone" in order to facilitate a first order change initiative to enroll more underrepresented students in computer science.

As I worked to institute my change project, I re-evaluated what was driving my leadership; I realized that my passion and my educational philosophy were the forces motivating me to seek new paradigms in computer science education. I was gaining a deeper understanding of my passions, my leadership, and what was driving me to seek this change. I also learned in this cycle that only through a team effort would my change initiative become a reality. This led me to utilize team learning and the dance of change (Senge, 1990; Senge, 1999) to facilitate the first order change initiative I sought.

The computer science pipeline, Facilitating Academic Triumph by Providing an Integrated Pipeline Experience (FATPIPE), sought to enhance the diversity, retention, and success of students in undergraduate computer science education at Rowan University. The flight of students from the computer science major will lead to shortages of graduates able to fulfill roles in industry, education, and research occupations. To address this dilemma, a computer science pipeline was established that provides opportunities for increased participation of underrepresented students, and increased retention and graduation rates. The computer science pipeline solution proposed in this cycle, FATPIPE, provided early intervention in the form of a Computer Science Alternate Route (CSAR) and a computer science learning community called Learning in Bits and Bytes (LiBBy). The CSAR provided an alternate path into the computer science major for students who fall slightly below the entrance requirements. LiBBy provided a support infrastructure to increase the success, retention, and graduation rates of computer science majors. Overall, the FATPIPE sought address the factors that drive underrepresented students away from the computer science major such as lack of math skills, gender and race socialization, lack of tutors and mentors, and education presented in a context that does not allow these students to construct meaningful learning environments.

Clearing the Path for FATPIPE

Work began on FATPIPE in January 2007 with a series of meetings with the computer science department chair and faculty, the math department chair and faculty, the Dean of the College of Liberal Arts and Sciences (CLAS), the Office of Student Affairs, the PCI administration, the registrar's office, and the Career and Academic Planning Center (CAP center). The meetings with the computer science chair were geared towards introducing the idea of FATPIPE and to gain departmental support. The department chair immediately decided to champion the project as entries from my journal indicate. This was instrumental in allowing me to move forward with my ideas.

"I think we need another way into the major"

"I definitely think we need more diversity in the major"

("OLIS Journal", January 9, 2007).

I think that the timing of my initiative was a major factor in its success and the department chairs' support of the initiative. The new university Provost had taken notice of computer science enrollment, so the department was actively searching for ways to improve the number of students in the major. The following entry from my field notes documents the Provost's goals for the university and the introduction of my ideas in a meeting with him and the Computer Science Department.

> "Went around the table and introduced ourselves and the provost explained his vision, goals, and obstacles faced for the university's future. He stressed that we must think outside the box to generate revenue. He touched on diversity, so I took the liberty of talking about my ideas, dept seemed ok with it." (OLIS Journal, January 10, 2007)

This meeting presented me with the opportunity to reflect upon my place in the department and the political aspects of my position. I learned that I must pick the right time and situation to put forth my ideas. The new directions that the Provost discussed provided me with the perfect platform for the FATPIPE program.

I also presented my work to the department faculty and staff at department meetings. I requested this as an agenda item for every monthly department meeting during the January 2007 to May 2007 time period. Obtaining the support of the department was the first step in implementing FATPIPE. I also noted that I seemed to be gaining a voice in the department as noted by the response I received to the FATPIPE proposal. As I utilized my leadership to facilitate my change initiative, I found myself gaining a deeper insight into the political frame of my organization. I was learning how to form coalitions and gain the support of the decision makers in my department. I had the support and backing of the department chair, which in turn paved the way for the FATPIPE project. Within the department there is a core group of faculty that holds all of the authority and decision making power. They set the goals and directions that the department follows. I was learning to use this to my advantage; the relationships I formed allowed me to push forward my agenda and needs. (Bolman & Deal, 2003)

"I read from prepared notes on my ideas. Everyone listened intently. No interruptions, no objections. Made me feel like everyone is starting to buy in to the ideas I have. What was strange was complete silence after my talk, this typically means from what I've seen that the idea has made an impact."

What did you learn: political aspects involved in working in an organization, how to interact; gain a voice (OLIS Journal, January, 2007).

The next series of meetings was with the computer science chair, the math department, and the PCI administration. This series of meetings was designed to start building the team that would be required to pilot the pipeline program. The FATPIPE program was outlined and the logistics of implementation were discussed. We all agreed upon the need for some form of math intervention and mentoring as components of the program. The decision that intermediate algebra would be the first math course was agreed upon. The group felt that this course would prepare the students for pre-calculus upon entering CSAR in the fall. I agreed to initially serve as the main point of contact for the mentoring component of CSAR, and the group also agreed that the PCI students would be a good starting point for the program due to the high percentage of underrepresented students that enter Rowan University through the PCI program. OLIS field notes and journal entries document these meetings. These meetings ushered in the beginnings of a shared vision of increasing diversity in computer science, of the team learning process (Senge, 1999) and my role of facilitator. My role as facilitator was to create a shared vision through my vision of FATPIPE, The department chair served as my source of power and took the lead in navigating the political frame (Bolman & Deal, 2003) of the various constituents we sought as team members. The entries that follow document the facilitation of the team building process as I practiced my leadership.

“ Brief introductions all around. Everyone looked at me to start the meeting off. I stated my idea and said we were here to discuss the logistics. Everyone like the idea, but major concern was math preparedness. We also discussed future plans for a CS pipeline that extends from K-12 to PhD. There were 15 strong possibilities for the test group; they had slightly higher SAT scores. (They have data that is internal, not part of Rowan IRB data). Discussed many different plans to enter CS starting with an awareness raising during 1st few days students are on campus, possibly seeking out students that are interested, and the class offered during the summer (PCI Administrator indicated how student light up when discussing computers) but still concerned about math prep, retention, and success rates. Talked about one EOF/MAP student who left CS major due to math problems. Discussed support structure needed to help students, I am support structure initially. Will hold mandatory bimonthly meeting with students. Discussed tie to proposed CS learning community. Came back to math concerns, decided to offer intermediate algebra, then ITP, then IOOP, so it seems the students would only be one course out of sequence. Math agreed to offer course if EOF/MAP provides the students, meeting ended” (OLIS field notes, February, 2007).

I learned the art of team learning, discussion, facilitating, politics, all the things I don't know, gaining voice, what it means to be a leader (you go out on a limb), mental models, what it is to be a participatory researcher

it seems more people actually read my work than I thought. A lot of things pointed out are on the table for discussion, great feeling of accomplishment for me (OLIS journal entries, February, 2007).

These initial meetings were crucial in the development of FATPIPE. Through these initial meetings, support was won for the project from various campus constituents with the power to pave the way for FATPIPE.

With the approval of the PCI administration, the CS chair and I proceeded to meet with the Dean of the College of Liberal Arts and Sciences (CLAS), the math department, the registrar, and student affairs to work out the logistics of implementing FATPIPE. The issues that were addressed in these meetings were reserving dorm rooms for LiBBy, holding seats in the intermediate algebra class for the summer 2007 second session, and holding seats in the introduction to programming and pre-calculus classes for the fall 2007. The summer class had to have the approval of the CLAS Dean and the math department. I introduced the Dean and the math chair to FATPIPE and obtained permission to proceed. These meetings were very brief and only consisted of me offering a quick overview of FATPIPE and asking if I could proceed with the project.

I then discussed running the special intermediate algebra summer course and reserving seats in the fall 2007 introduction to programming and pre-calculus courses with the registrar and student affairs. The student affairs administration handled setting up LiBBy, which was actually being developed in parallel with FATPIPE for the incoming regular admit CS students. The CSAR students would be given the option to participate in LiBBy, meaning those that chose to participate would be housed with the incoming CS freshmen.

The department had already initiated the formation of a learning community, under the guidance of the Vice President of Student Affairs, as a means of enhancing the first year experience for incoming freshmen and to increase retention, and a team was formed to apply for funding for the learning community under the National Science Foundation Course Curriculum and Laboratory Improvement Program (CCLI). I was part of the CCLI team and presented the idea of implementing FATPIPE as modules consisting of the learning community and the alternate route into the major. This presented me with further opportunities to practice my leadership, role as facilitator, and team building skills.

> I actually witnessed how a team learns. First everyone made sure their needs were met, before their defense routines dropped. The power group of the computer science department made it known they were still in charge and the grants office made sure their role was clearly defined and understood. Then we moved to a common start point which I pushed (this is what I need, it's my idea, so I should lead) and started to discuss. My defense routines and emotions kicked in, felt my idea (FATPIPE) being taken over. I must learn to trust others, can't do it alone, but I have a major problem with this. Am I wrong to feel that way? Want to trust, but given no reason. I will keep working and see what they come up with. Noticed two team members stayed away, like they knew this was going to be the big takeover event. It's clear my emotions are in this, it's my idea, I wrote the draft, so my body language and tone reflected this. So we are now in the delay phase, the takeover attempt was made and my plan is to sit back and see what happens (OLIS Journal entry, March, 2007).

I was learning to employ reflective practice as I navigated the political frame of my organization. Through my journal entries, I was able to step back and survey the playing field and the players as I struggled to implement my change initiative. I was starting to gain a deeper understanding of what drove my leadership. Through reflective practice I could now see that initially my transactional leadership always surfaced first, but to build a shared vision and step into my role as facilitator (Argyris, 2001, Kegan & Lahey, 2001, Senge, 1999), I had to understand my underlying assumptions and the effect my leadership theories in use had upon others. I was learning to "talk the talk", gain a voice, and build social capital within my organization (Putnam, 2000) by utilizing the transformational and feminist components of my leadership.

The department chair was instrumental in the success of the FATPIPE initiative. The chair provided guidance on navigating the policies and procedures and provided valuable input on how to structure FATPIPE. One major hurdle that I had to overcome was how to provide a path into the CS major for students with SAT scores in math that were below the entrance requirements. The chair provided the idea of admitting the students as an internal transfer as documented in an email entered into my journal.

> Hi, We can't officially admit the students to CS if they don't meet the criteria for Freshmen (I think right now it's 540 math SAT) without getting the approval of the dept, and possibly the dean. I thought the idea was the following: they're admitted in a sort of "pre-CS" program. They take Intermediate Algebra over the summer, and Intro in the Fall. The agreement is that if they get a (whatever it is -- I think B+) or better in Intro, then they're automatically in the major. But even before they're in the major, as a "pre-CS" major in EOF/MAP, they're contractually obligated to meet with you twice a month or whatever. Hmmm, so it occurs to me that even if they don't declare as "pre-CS" they could do the same thing (Interm. Alg in summer followed by Intro in Fall) and get into CS as an internal transfer. But obviously it benefits them if they meet with you twice a month. What do you folks think? How do we entice them to officially be "pre-CS" when, strictly speaking, they don't have to do so? Is that something that EOF/MAP does regularly -- add other requirements to the students' contracts? So this would be fairly normal? Also, in terms of the learning community, the plan is to have all those kids taking OOP1 in the Fall, which the kids that don't have

sufficiently high SAT math aren't ready for yet. So we need to figure out how to work that out. They won't be in at least one of the linked courses (OOP1) and I thought that the pilot for the learning community was setting up for only 20 kids which is a full section of a Rowan Seminar. So if there's 20 Freshmen who are officially majors in the program, there's no room in the class for anyone else. (OLIS Journal, March, 2007)

The issue of the low math SAT scores was solved and the next step was to work with the PCI administration and the math department to work out the logistics of CSAR and allow us to target the summer 2007 EOF/MAP cohort. Additionally, work on the course sequences that the students will follow started in this phase of the project. CSAR was developed for EOF/MAP students to enter the computer science major as an internal transfer. The purpose of CSAR is to increase diversity in the major by enrolling 5 % of the incoming EOF/MAP students. Additionally, the program will allow the students to strengthen their math skills and be introduced to the concepts of computer science and programming as a means of providing intervention to overcome inadequate math preparation and computer skills. The students will follow modified schedules (Appendix C). The schedule that the students will follow is based upon their success in the first semester. Perna (2003) argues that academic preparation in pre-college education is a key factor in college enrollment and success. The modified schedules represent an attempt to provide intervention in math and basic computer science based upon the students' grades in their first semester.

CSAR is significant for underrepresented students because it is an attempt to overcome stereotypical threats such as poor math preparation and socioeconomic factors (Sax, 1994a; Sax, 1994b; Sax, 1995; Sax, 1996; Smith & Lusthaus, 1995; Williams, 1960). The success of this initiative will empower the students to become future educators, researchers, and workers and to provide mentors and role models for future generations (Sandra, 1994). Additionally, Rowan University will continue to fulfill its commitment to diversity and provide graduates able to contribute to and participate in a technological society.

With CSAR setup and the course sequences in place, I learned that there were still other issues to be addressed. The incoming EOF/MAP students are undeclared and as such it is the responsibility of the CAP center to advise the students, and the CAP center informed me that we could not call the program a pre CS major since there are officially no pre majors at Rowan University, this was the driving force behind the name CSAR for the alternate route program. Additionally, I learned that the registrar wished us to open CSAR up to all undeclared freshmen, but we felt this was too much to undertake in the FATPIPE pilot. We did discuss expanding the program in the fall 2008 to open CSAR up to all undeclared students. The Student Affairs department was instrumental in helping me to solve these issues and placed me in contact with the proper personnel to work out the issues.

> Since these students are undeclared students, I would suggest that we meet with the CAP Center, the Registrar and the College of Continuing and Professional Education to discuss how this will take place during the summer months so that adequate CAP Center advising and registration can be completed for these students. I am free after 10 a.m. on Wednesday unless something else comes up before we confirm this meeting (OLIS Journal, April, 2007).
>
> The CAP Center is responsible for advising all undeclared students therefore I need to be a part of any further discussions concerning undeclared students. I am not available this Wed. at 10:00 a.m., however my secretary can arrange a

convenient meeting time. Please keep in mind that Rowan does not have any pre-majors (OLIS Journal, April, 2007).

The advising and mentoring of the CSAR students was the final piece of FATPIPE that was worked out with the CAP center and registrar administration. I learned through the meetings with the CAP Center administration that the center is responsible for advising all undeclared majors and that the center required a Freshman Instruction Guide (FIG) to ensure students received the proper guidance when selecting their schedules. The CSAR participants would be undeclared until they passed the fall 2007 courses, so the CAP Center would be responsible for advising them. This lead to the development of the CSAR course sequences (Attachment C) that were supplied as FIGs to the CAP Center. It was also agreed that initially I would serve as the main mentor to the CSAR students.

The Future of FATPIPE and My Leadership

This cycle of the study allowed me to answer the question, How can my leadership improve interest/enrollment in computer science education at Rowan University for underrepresented students? I answered this question as I practiced and gathered data on my leadership while I facilitated the creation of an educational pipeline in an attempt to increase diversity and enrollment in computer science. I realize there is still a lot of work and leadership challenges in the future as I attempt to institutionalize FATPIPE. The pilot project seemed successful in the context of raising awareness about computer science and the flight of students from the computer science major across many departments on campus. I consider this the first order change that I sought in this project, a short term change. In order for FATPIPE to truly be successful, second order change must be achieved by institutionalizing FATPIPE (Bartunek, & Moch, 1987). My leadership also underwent change, both first and second order change. I learned how dance the Dance of Change, to begin to talk the talk, the importance of reflection, and to see and practice what I learned over the course of my studies in action (Kegan, & Lehey, 2001; Senge, 1990; Senge, 1999). I practiced short term modifications as I stepped outside of my comfort zone to accomplish this study, but underneath I broke my single loop mode (Argyris, 2001) by re-evaluating my assumptions and practicing what I actually espoused as my leadership.

Chapter 8

Cycle IV

Facilitating Academic Triumph by Providing an Integrated Pipeline Experience (FATPIPE)

"The greatest revolution in our generation is that of human beings, who by changing the inner attitudes of their minds, can change the outer aspects of their lives" - Marilyn Ferguson

Introduction

Facilitating Academic Triumph by Providing an Integrated Pipeline Experience (FATPIPE) seeks to enhance enrollment, diversity, retention, and success of students in undergraduate computer science education at Rowan University. The flight of students from the computer science major will lead to shortages of graduates able to fulfill roles in industry, education, and research occupations. To address this dilemma, a computer science pipeline must be established that provides opportunities for increased participation of underrepresented students (Camp, 1997; Jepson, & Perl, 2002; Kerner, & Vargas, 1994; Pearl, Pollack, Riskin, Wolf, Thomas, & Wu, 1990; "Minority Participation in R&D", 1981; "Blacks Increasingly Are Moving into the Business Ph.D. Pipeline", 1996), and increased retention and graduation rates. The computer science pipeline solution proposed in this project, Facilitating Academic Triumph by Providing an Integrated Pipeline Experience (FATPIPE), seeks to entice more students to enroll in computer science at Rowan University. FATPIPE will consist of components that will serve as incentives for those that choose computer science. FATPIPE will offer scholarships, provide a Computer Science Alternate Route program (CSAR), and a computer science learning community called Learning in Bits and Bytes (LiBBy). The scholarships will provide a financial incentive to entice more students to choose computer science, the

CSAR will provide an alternate path into the computer science major for students that fall slightly below the entrance requirements, and LiBBy will provide a support infrastructure to increase the success, retention, and graduation rates of computer science majors.

Overall, the FATPIPE will address the factors that drive students away from the computer science majors such as lack of math skills, gender and race socialization, lack of tutors and mentors, and education presented in a context that does not allow students to construct meaningful learning environments (Croom, 1984; Griffin, 1990; Hill, 1990; Stockard, Klassen, & Akbari, 2005).

FATPIPE Description

The purpose of FATPIPE is to implement a Computer Science Pipeline. The goal of the pipeline is to increase diversity, enrollment, and facilitate the retention and success of computer science students at Rowan University. The main focus of this cycle was to design and pilot the initial components that will serve as the framework of FATPIPE:

1. Design and pilot an alternate route program into the computer science major for underrepresented minorities and women to increase diversity in the major by enrolling 6% to 12% of the incoming PCI freshmen.
2. Design and pilot a learning community to provide a first year experience that fosters the success and retention of entering majors and acclimates them to the rigors of the computer science major and the college experience.

Decline in Computer Science Enrollment at Rowan University

During the 2000 to 2006 time period, enrollment in computer science experienced a significant decline. Total enrollment dropped 39% over this period and the number of underrepresented students declined. Nonwhite students were 29% of the computers science majors in 2000 and declined to 21% of the computer science majors in 2006. Additionally, the female population, exclusive of ethnicity, of the computer science major declined from 23% to 5% over the same period. This decline follows a nationwide downward trend for women in computer science and a level or slightly upward trend for underrepresented minorities (http://www.nsf.gov/statistics/seind06/).

Detailed Project Plan

The purpose of Project FATPIPE is the development of the framework for a computer science pipeline. The purpose of this pipeline is to increase enrollment, diversity, retention, success, and graduation rates for the Computer Science Department. Success in the computer science profession means that more computer science educators, workers, and researchers will be available to add to the profession and to provide role models for future generations. The following is a description of how the pipeline was created.

Alternate Route into the Computer Science Major for EOF/MAP Students (CSAR)

Rowan University is a higher education institution that has implemented a summer bridge program as an alternative means for underrepresented students to pursue a college education. Rowan University's PCI is comprised of two components, the Educational Opportunity Fund (EOF) for students from low income families and Maximizing Academic Potential (MAP) for students who failed to meet the minimum entrance requirements, but show academic potential. Incoming EOF/MAP students attend an intensive five-week PCI program held on campus from July to mid-August. The institute takes a disciplined approach to teaching the survival skills necessary to succeed in college, and the participants have the opportunity to earn college credits during the summer program. Students participate in course work, structured study periods, group discussions, and other activities that promote academic and personal success. At the end of the program, the PCI staff evaluates student performance records then recommends admission or denial of admission to Rowan University.

The overall goal of the PCI program is to better prepare underrepresented students academically to face the rigors of college level coursework and to help them to adjust to the college environment. These factors in turn increase the retention and graduation rates of underrepresented students (Ackerman, 1991; Ami, 2001; Buck, 1985; Evans, 1999; Fitts, 1989; Garcia, 1991; Suhr, 1980).

A pre-computer science major was developed as an alternative route for EOF/MAP students to enter the computer science major as an internal transfer. The purpose of CSAR is to increase diversity in the major by enrolling 6 to 12 % of the incoming EOF/MAP students. Additionally, the program will allow the students to strengthen their math skills and be introduced to the concepts of computer science and programming as a means of providing intervention to overcome inadequate math preparation and computer skills. The students will follow modified schedules that provide options depending upon the grades received in the initial semester in the program (Appendix C). The fast track schedule that the students will follow is based upon the successful completion of Introduction to Programming and Pre-Calculus in the first semester. The slow track course sequences that the students will follow are determined by the grades they receive in the initial CS courses. The reasoning behind the slow track course sequences is based upon the requirements to enter the CS major as an internal transfer. The requirements for an internal transfer are a B+ or better in Introduction to Programming and Pre Calculus. The students are place on the slow track for failure to achieve a B+ or better in the courses as a means of providing math and basic computer science intervention. Perna (2003) argues that academic preparation in pre-college education is a key factor in college enrollment and success. The modified schedules represent an attempt to provide intervention in math and computer science based upon the students' grades in their first semester.

The pre-computer science major is significant for underrepresented students because it is an attempt to overcome stereotypical threats such as poor math preparation and socioeconomic factors (Sax, 1994a; Sax, 1994b; Sax, 1994c; Sax, 1996; Smith & Lusthaus, 1995; Williams, 1960). The success of this initiative will empower students to become future educators, researchers, and workers and to provide mentors and role models for future generations (Sandra, 1994). Additionally, Rowan University will continue to fulfill its commitment to diversity and provide graduates able to contribute to and participate in a technological society.

Learning in Bits and Bytes (LiBBy)

Learning communities by definition provide social contexts of development. Edgar H. Schein (1992) explored an organization from the inside out by looking at the underlying culture in an organization. Schein explains how to analyze an organization by understanding its culture on the three levels. Schein defined the levels using the analogy of a child and how a child is reared by its parents. A child is taught a set of beliefs, behavior and values from birth, through maturity. As the child goes out into society and interacts with others it evolves through new information learned through these interactions. Schein sees each evolution in an individual’s life as a death and rebirth. The central theme is that an organization is like a child, which must be taught as it grows and counseled as it matures and changes to face challenges of a world that is constantly evolving. As a parent, I can appreciate how a society is born and grows, just as a child does. As parents, we instill in our children a base set of beliefs, behavior and values. From birth they are taught our value system and how to react to stimuli to the base needs and assumptions.

This theory holds true for LiBBy, the students in LiBBy are its citizens and there will be a culture in LiBBy based on shared beliefs, behavior, and values. In a society, there are also many subcultures due to cultural differences based on ethnicity and socioeconomic backgrounds. Underlying all of these subcultures is a universal culture that allows the society to function as a whole in spite of the diversity of its citizens. LiBBy will seek to build a strong community based on shared beliefs, behavior, values, and diversity by allowing students the opportunity to develop meaningful relationships with other students, peer mentors, and the computer science faculty. Lave & Wenger (1991) have argued that a true sense of community develops faster when students are engaged in problem solving with more experienced peers and adult mentors. Through LiBBy, we seek to encourage students and mentors to model learning practices that help novices begin to gain the analytical, problem solving, and organizational skills it takes to think like computer scientists.

The design of LiBBy is consistent with Tinto's (1993) belief that effective retention programs include a commitment to providing needed attention to all students daily. LiBBy will mirror this belief in providing frequent interaction between students, faculty, advisors, and staff. The community will include interaction with a program coordinator who can provide necessary support and address new student concerns. The community will also involve upper class students who will serve as mentors to group members. Grouped residential housing and linked courses, integral to the community concept, will encourage interaction between faculty and students both in and out of the classroom. Frequent and rewarding interactions are critical for student persistence (Tinto, 1993; Damminger, 2004). Tinto (1993) claims that such interaction, in educational learning environments, also enhances the likelihood of student development both intellectually and socially. Additionally, educational learning environments that link social and academic learning can create engaged learners who are active participants in their own education (Vygotsky, 1978).

Linked Course Sequence for First Year Computer Science Students

A learning community is characterized as any purposeful curricular restructuring to coregister students for two or more paired courses to accomplish predetermined goals (Gabelnick, MacGregor, Matthews, & Smith, 1990; Smith, Henscheid, & Matthews, 2003; Damminger, 2004). Benefits can include retention, social and academic integration, intrusive academic advising, developmental career life planning, and interdivisional collaboration. Research suggests that collaborative learning environments, such as LiBBy, can develop peer relationships, enhance broader social bonding, and integrate students in an institution's academic life (Gardner & Levine, 1999; Tinto, 1993; Dammiger, 2004).

Following the learning community model, which is characterized as any intentional curricular structure registering students for two or more linked courses to accomplish community goals (Gabelnick et al., 1990; Smith, Henscheid, & Matthews, 2003; Damminger, 2004), computer science freshmen will be registered together for two classes in the first and second semesters. The benefits of such linked courses include those previously mentioned and social and academic integration, intentional advising, developmental career planning and interdivisional collaboration which are additional goals of LiBBy.

The FATPIPE Pilot

The launch of FATPIPE began on July 8, 2007 with a one hour meeting with 15 incoming EOF/MAP students. The purpose of this meeting was to introduce the students to the possibilities available to computer science graduates. The students received a handout from the Association for Computing Machinery (ACM) that outlined computing degrees and careers, my formula for succeeding in the computer science major (Appendix E), and the purpose and structure of the FATPIPE program. The students scheduled for the meeting were EOF/MAP students that expressed an interest in computer science. The students seemed enthusiastic about a career in computer science and the input that was given indicated an understanding of the value of a computer science degree. They seemed inspired and strongly interested in the computer science field.

> "I know a friend who has a computer science degree and works for Lockheed Martin. He makes a lot of money!!!"
>
> "I've always liked computers and video games; it would be nice to learn more about them"
>
> "I would really like to learn how to program video games" (OLIS field notes, July 2007)

The selection of the students that participated in this meeting was arranged by the EOF/MAP administration. These students would be provided the opportunity to enter the computer science major as an internal transfer after the successful completion of courses designed to enhance their math and basic computer science skills. The students selected were placed in a math course, Intermediate Algebra, which was designed to prepare them to take pre-calculus in the fall of 2008. The purpose of the Intermediate Algebra course was to provide math intervention to this group of students. The criterion for selecting the students was determined by the EOF/MAP administration based upon information received from the students as part of the application process to the PCI program. The students' math preparation was a major concern when the CSAR program was being formulated because the average SAT math scores of the incoming PCI students falls below the 540 minimum to enter the computer science major as a normal admit (Table 15).

On July 9, 2007 I met with a different group of fourteen EOF/MAP students that were placed in the Intermediate Algebra course. The students in the course were a different group of students selected by the PCI administration based upon their math preparation coming into the program, as well as their interest in the computer science major. The students were introduced to the purpose and structure of FATPIPE and the importance of succeeding in the Intermediate Algebra course. The demographics of the fourteen

Table 15

SAT Scores for Incoming Freshmen

Yr/Admit	Number	Verbal SAT	Math SAT	HS Rank
Fall 2001				
Regular	1027	559	574	76
Special	97	463	467	46
EOF	117	399	411	58
MAP	36	457	451	59
TOTAL	1282	534	547	72
Fall 2002				
Regular	1003	565	583	77
Special	93	468	466	48
EOF	126	390	415	60
MAP	44	448	479	61
TOTAL	1266	536	555	73
Fall 2003				
Regular	999	567	586	76
Special	99	476	475	45
EOF	110	401	411	56
MAP	38	463	460	54
TOTAL	1246	542	558	72
Fall 2004				
Regular	1009	568	583	76
Special	83	463	485	49
EOF	123	406	418	56
MAP	45	460	457	56
TOTAL	1260	541	556	72
Fall 2005				
Regular	1000	571	590	78
Special	86	484	485	48
EOF	120	401	423	59
MAP	41	434	439	57
TOTAL	1247	554	562	74

students were roughly 50% male and 50% female and ethnically diverse with Hispanic/Latino, Asian, and African American being the majority. At the completion of the summer course the students will officially become CSAR members and offered the opportunity to participate in LiBBy for the fall 2007 semester. If the students decided to participate in LiBBy, they would be housed in a common dorm with the incoming computer science freshmen cohort. The learning community is designed to facilitate the formation of a cohort. The community will involve upper class students who will serve as mentors to group members. Grouped residential housing and linked courses, integral to the community concept, will encourage interaction between faculty and students both in and out of the classroom. Frequent and rewarding interactions are critical for student persistence (Tinto, 1993). Tinto (1993) claims that such interaction, in educational learning environments, also enhances the likelihood of student development both intellectually and socially.

On July 23, 2007, I briefly meet with the instructor for the Intermediate Algebra class ten minutes prior to the start of his class to discuss the progress of the students. I asked him how the course was progressing and he expressed great delight in how enthusiastic the students were and the progress they were making. The average score on the first test in the class was 80 out of 100. I told him how delighted I was and that I hope the students continue to do well. This was a very brief meeting because I stopped in to see the instructor ten minutes before the start of the instructors' class.

On July 24, 2007, I briefly met with the PCI administration to get a feel for how any of the students enrolled in the intermediate algebra class were actually going to participate in CSAR. I asked if the fourteen students in the intermediate algebra class all passed, would they all become CSAR participants? I was informed that the majority of the students would be continuing on towards entering the CS major, but not given an exact number. The PCI administrator informed me that they still had data to go through before they finalized the fall schedules for the students.

Summer 2007 FATPIPE Pilot Wrap-up

On August 2, 2007 a meeting was held with the PCI administration to discuss the number of students that would continue FATPIPE in the fall 2007 and the future of the FATPIPE program pilot. This was a strange meeting and many things were brought to light which seemed to be a major setback in the project. There were unanswered questions about the logistics of selection of the students that participated and the future of the collaboration between the computer science department and the PCI program. Politically, I think this was due in part to a pending change in the leadership structure of the PCI program. My field notes document this interaction.

> My list of questions started with asking about the logistics of enrolling the students in CSAR. The PCI administrator informed me that the schedules are setup by the CAP center, but they can make adjustments. I then asked about including the students in the learning community. I was told that this is optional and historically students want to live on campus with their friends initially, but we would offer the option of participating in the learning community. The discussion then moved to the future of FATPIPE. I was informed that there were two students that want to go into CS, I asked if they were in the intermediate algebra class, was informed they were not. I asked when we would know who from the class would continue on in the program. PCI administrator informed me that he still needs to go through some data and will know for sure in a week or two. He then started to tell me how the students complained that the class didn't count towards their major. I said we have to let them know that the class is to prepare them for the math in the computer science. PCI administrators said they were

> going to talk to the students in the meeting scheduled for that night and tell them the story of PCI students that chose biology, but failed pre-calculus, then enrolled in college algebra to try and catch up in math before retaking pre-calculus, but also failed that class and was dropped from the biology major. I agreed that this would be a good way to let the students know how important math skills are in STEM majors, and that FATPIPE is designed to provide intervention in math. I then asked if the students that passed the summer course would be continuing in the fall, but the PCI administrator told me he wasn't sure at this point. I thought this was strange. I was under the impression that the students in the math course were the students that were placed there because they expressed an interest in computer science. The response was kind of vague, "I still need to go through my data" was the administrators' response and he kept looking for a data file on his computer. I asked how can we formalize the process for the future ? The response was "maybe we can work with the CHAMP program", I was confused at this point. I knew about CHAMP, but it was never discussed in conjunction with FATPIPE before. We also discussed the fact that a new PCI administrator was coming on board, and it was not clear how things were going to go, I expressed the need to continue this work, and the Assistant director agreed to work with me to keep the program moving. "I will need to give the need director some time to settle in before I approach FATPIPE, but I will bring it up". I thanked him and setup a follow-up meeting to finalize the number of students that will continue on in the fall (OLIS field notes, August, 2007).

This meeting presented an entire new set of challenges that must be overcome to institutionalize FATPIPE. If the collaboration between computer science and EOF/MAP was to continue I would have to win over the new PCI Administrator. I would also need to work on formalizing the selection process for students that express a desire to enter the computer science major; I am not sure how the current selection process worked. I talked to one group of students in the awareness raising meeting, then an entirely different group was assigned to the intermediate algebra class, and the students that have selected computer science so far are not from the summer class.

On August 16, 2007 I contacted the PCI administrator to get the names of the students that would be enrolled in FATPIPE. I was informed that one of the two candidates that we had previously discussed had not been admitted to Rowan and he was not sure if the second students' schedule. I asked him if the students enrolled in the intermediate algebra class would be enrolled in FATPIPE and his response was that he was out of the office on vacation and would look up the information when he returned in a week.

> "Starting to worry about how many students will be enrolled. I need to get this information to the registrar and learning community coordinator." (OLIS Journal, August, 2007)

On August 17, 2007, I contacted the instructor that taught the intermediate algebra class via email to check the final outcome of the class. The instructor informed me that 80% of the students had passed the class with a B or better and that he really enjoyed the class. I discussed this information on to the PCI administration only to find that they were out of the office.

> Looks like all the students passed the intermediate algebra class!!!!
> Does this mean they will continue on in the CS Pipeline program??
> Hopefully we can get together soon to wrap this up. I'll be available next week(OLIS journal entry, August, 2007).

On August 20, 2007 I contacted the PCI administrator to discuss the students that were enrolled in the summer 2007 intermediate algebra class. I informed him that I was receiving calls from my dept chair in reference to the number of students that would be enrolled in the fall 2007 introduction to programming class. I was informed that it was the students choice as to what major they choose. I was under the impression that the students in the math class were targeted to continue on in the FATPIPE program. I informed the department chair of this new information and decided to send an email and letter to the students that were enrolled in the math class. We agreed upon a deadline of August 31, 2007 as the cutoff date for the students to make their decision. These communications illustrate the obstacles that I was faced with in implementing FATPIPE. I realized that I must serve as the catalyst if the program is to be a success. I plan to incorporate the lessons learned as I attempt to institutionalize FATPIPE.

Lessons Learned from FATPIPE Pilot

The obstacles that presented themselves during the pilot of FATPIPE were centered on administrative issues and politics. I was unable to focus my attention on the students as I strove to navigate the political landscape of my organization. I was at the mercy of the administration in the departments that were part of the project. I was not privy to the behind the scenes workings of these departments, and I was reluctant to push too hard for fear I would alienate the team members. I was allowed to look in the window, but not actually enter and be a part of the inner workings. As I worked to implement this change project I was faced with the defense routines of the various departments that were involved in the project. Chris Argyris (1990) called these worldwide errors, which are typical of organizations running in Model I mode.

- Error 1 - actions that are intended to create understanding and trust often produce misunderstanding and mistrust. The process is designed to keep the power in the hands of the few.
- Error 3 - Organizational inertia. This error perpetuates a status quo mentality.
- Error 5 - Budget games are necessary evils. In general, all the departments on campus have a limited budget and politics are caused by limited resources.
- Error 7 - The management team is a myth. The general tendency in academia is one of individuality. This is not very conducive to team work.

These errors have caused defense routines to be setup, which perpetuates committing the errors over and over. Fancy footwork and malaise are evident in what is espoused and there is a general feeling that if the status quo is changed, the department may be vulnerable to some hostile takeover, so there are always hidden agendas (Argyris, 1990). Politics and budgetary games are standard fare and collations exist throughout the organization. This leads to malaise and fancy footwork, where no individual or group wants to upset the system. My observations have led me to the conclusion that small or incremental change is the only way to cause tipping points. I practiced this over this change project, I was persistent and kept light pressure applied in an attempt to make my ideas sticky, then others started to embrace the change as their own and it became something they felt worth implementing. I also used this tactic during the team building initiative. I had to frame my idea differently for the various constituents, but underneath it was still a team building initiative, it became sticky when I suggested the name FATPIPE for the project. This was Gladwells' (2000) theory of the stickiness factor in action. All organizations have slogans and catch phrases that serve to help people understand and remember the companies' goals and mission. This is true across many sectors in the real world. In education there are phrases such as "No Child Left Behind". In industry there are catch phrases such as “world class” and in government there are phrases such as “NJ and You- Perfect Together”. The author’s stickiness factor is believable and understandable and I have seen it work (Gladwell, 2000).

Conclusions

The FATPIPE wrap-up was the end of my change initiative, not in the sense of completion, but the end of a phase. Many things were revealed to me over the course of the FATPIPE pilot that I will reflect upon in an effort to better focus my vision and to develop a plan to push forward in the future. I learned how to gain a voice and build social capital by walking the walk and talking the talk (Kegan & Lahey, 2001), as well as the protocols and the subtleties of the dance of change. I learned what vision is, why it is so necessary to great leadership, and how to develop it, and how to create winning teams and keep them following my vision (Argyris, 2001; Senge, 1990; Senge, 1999). I learned what it takes to be a leader and gained a deeper understanding of my own leadership. I learned how to be flexible and adaptive without compromising my principles, and that leadership is an ongoing process.

On a professional level, I actually practiced my leadership in everyday life, and stepped outside of my comfort zone to take a more active role in my community, and the world at large. I practiced and observed what I had learned over the course of my studies. I witnessed defense routines in real world situations (Argyris, 2001), I better understand the political frame structural frames of my organization (Bolman & Deal, 2003), and I learned the importance of relationships, coalitions, and teamwork (Putnam, 2000; Senge, 1990; Senge, 1999; Wheatley, 1999; Zohar, 1990).

Chapter 9

Cycle V

Leadership Reflection

> "Men do change, and change comes like a little wind that ruffles the curtains at dawn, and it comes like the stealthy perfume of wildflowers hidden in the grass" - John Steinbeck

Talking the Talk, Gaining a Voice, and Building Social Capital

Robert Putnam (2000) argues that people born during the prosperous economic conditions of the 1960s and onwards, are less inclined to engage in community life and in politics, and also less likely to trust their fellow citizens. By contrast, people born roughly between 1910 and 1940, are portrayed as much more motivated in these respects. Putnam (2000) argues that a process of generational replacement is responsible for a steady decline of social capital and civic engagement in American society.

This study presented me with the opportunity to overcome my bowling alone mentality by better understanding myself, my leadership, and my place within the organization. As I cleared the path for FATPIPE (chapter 7), my observations and journal entries provided me with the data to help me better understand myself and my leadership. I was able to gain an understanding of where I fit in my organization, to understand the political landscape of my organization, how to dance the dance of change, and the art of team learning. The pilot of FATPIPE (chapter 8), also provided data that helped me to better understand what is required to implement change. I was faced with many administrative obstacles that I had to overcome in order to see the project through. I had to step outside of my comfort zone and use my leadership to navigate the political landscape of my organization. I realized that "bowling alone" would only allow me to reach certain goals.

I viewed my life and my leadership using the analogy of the captain of a boat sailing on the river of life. I felt that as the captain of the boat “ME” I responsible for where “ME” went in life without any help from outside. If I failed or succeeded it was because of my actions. I was operating in a transactional mode for the majority of my life. Through the study of myself and my leadership I realized that there is more involved than just a system of rewards for work. I learned that relationships and politics play a large part in the degree of success that one can obtain. Relationships are the ties that bind the group together and relationships must be nurtured and allowed to develop because they lead to interactions among the individuals that have a direct effect on group or organization dynamics (Bartunek, Walsh, & Lacey, 2000; Cancian, 1992; Grogan, 2000; Hill-Davidson, 1987; Kezar, 2000; Ropers-Huilman, 1998).

Margaret J. Wheatley (1999) presents a new way of thinking about relationships and their place in an organization. This new mode of understanding relationships and organizations is based upon quantum science. In the Newtonian view of an organization, it is a closed system that runs on its own accord and is prone to breakdown of the individual parts. The parts are replaced and the machine runs, but the basic design never changes. In the quantum view this is not actually the case; the organization is a dynamic system that is constantly changing due to interactions and relationships with other organizations and the world it exists in creating new realities and evolving organizations.

The Newtonian view of an organization is one of a closed system that is tightly controlled and hierarchical (Wheatley, 1999; Zohar, 1990). Rules and procedures are put in place to cover every possible disturbance to the organizational system and communication within the organizational system is highly structured. This is a view based upon the old science; everything in the world can be controlled and tamed. Wheatley (1999) believes that this view leads to the eventual demise of the organization because there is no self renewal. In a closed system without feedback from external stimuli and internal change to accommodate those stimuli, there is no self renewal of the organization and it decays and dies (Wheatley, 1999).

When looking at the world in the quantum view there are no controls or boundaries and everything is in a constant state of flux. The quantum world is always on the brink of chaos, but within this chaos there is order and evolution. As an entity experiences stimuli or encounters other entities in its environment, it changes, reacts and adapts to this stimuli. No longer is there an individual part that does a specific task, but every part has a relationship with every other part and as they interact with each other, new possibilities are born. So in an organization all the parts have relationships and interact with each other and to external stimuli, and are in a state of change, which leads to new identities and a total utilization of resources and potential (Wheatley, 1999; Zohar, 1990).

Wheatley (1999) then looks closer at how this quantum theory is applied to organizations. In this frame an organization is not just a machine with parts that perform a specific task, but a living breathing organism in which each part plays a part in the whole and all are bound together by invisible forces. The forces that bind the parts of an organization together are the culture, values, and ethics according to Wheatley (1999). These forces also determine how the organization behaves. So what Wheatley (1999) presents is a picture of an organization that is self renewing and bound by its core values, culture and ethics, but these are dynamic constraints that bend and flex depending upon the situation. Management, procedures, and policies cannot function in this realm because these forces are not concrete and the controls that the old organization structure wants to put in place are dependent upon clearly defined constraints and division of labor.

Zohars' (1990) theory of the quantum self justifies Wheatleys' (1999) view of a quantum organization from the standpoint of quantum physics. The quantum self is a condensate that is the result of interactions and relationships among quantum particles. The quantum self then interacts with other quantum selves and evolves to different states of awareness. These new states of awareness are relationships that can vary in the degrees of intimacy. These quantum entities and the relationships that are formed are what organizations are composed of, so one can extrapolate that an organization is also a quantum entity. This quantum entity interacts with other quantum entities and evolves to new levels of awareness. Figure 16 illustrates the formation of an organization from a quantum viewpoint.

I now understand myself and who I am as a leader from a personal perspective, the theories that I have been practicing, and my place within an organization. I now understand that I use the transactional leadership theory to motivate individuals. I use the feminist leadership to develop and nurture relationships and build trust and I use the transformational/ethical and charismatic leadership to motivate, inspire, and achieve

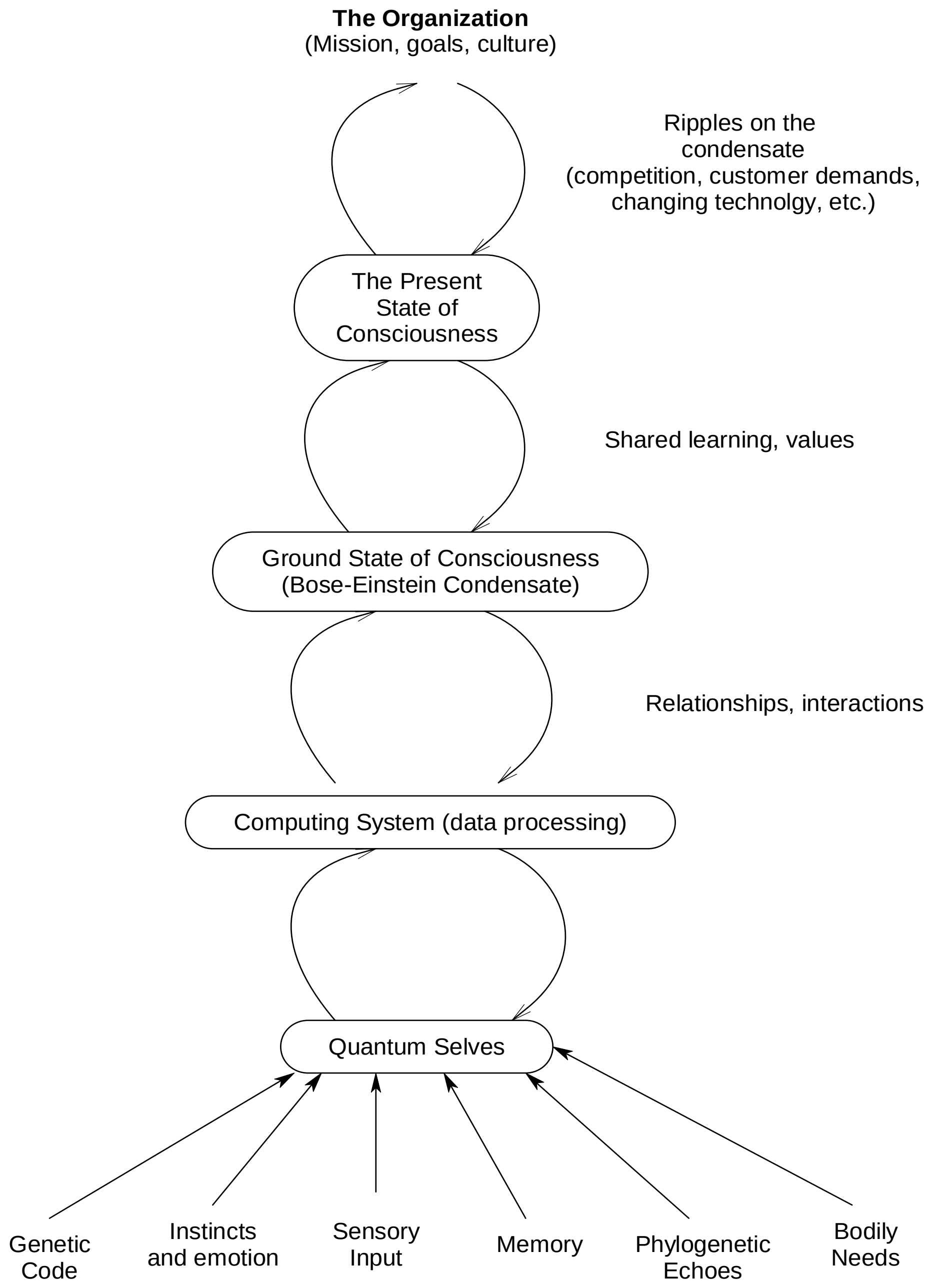

Figure 16. The Quantum Organization. The quantum organization is composed of quantum selves that interact and relate to each other to form a new whole with shared goals and visions. This new whole is the Bose-Einstein Condensate that is the base organization and external factors cause evolutions that create the quantum organization.

long-term success. I also understand the relationships between the individual theories that I subscribe to; I understand that transactional and transformational/ethical leadership are intertwined, that transactional, transformational/ethical, and charismatic leadership balance each other and that feminist leadership is the glue that binds my leadership together. My leadership can further be summarized using the analogy of fishing to describe how the theories I subscribe to meld together.

F - Friends

- Relationships are the invisible bond that ties us together
- Relationships foster trust, communication, tolerance, shared goals and vision
- Through relationships new possibilities are realized
- The Feminist Leader realizes that these relationships must be nurtured and allowed to develop

I - Individuals

- Each person is an individual with wants and needs that must be fulfilled and the group is comprised of individuals who share common goals and needs that must be fulfilled
- Transactional Leadership allows me to challenge and reward the individual
- Transformational Leadership allows me to challenge and reward the group

S - Self

- Know thy self, what drives us, our wants, needs, strengths and weaknesses
- Only by looking inside can we understand what motivates and drives us as an individual
- This understanding prevents getting "Lost in the leadership role"

H - Home

- A leader must have anchors
- Keeps us grounded and keeps things in the proper perspective
- Provides a release from the leadership role
-

I - Incentive

- Individuals need incentives or challenges
- Keeps them interested and motivated
- Individuals are driven by the same wants and needs that drive the leader and these must be addressed
- Transactional leadership ensures needs are met

N - Needs

- Individual needs over emphasized in a leadership role
- Must understand our needs to be able to control them
- Anchors help us control these needs and wants

G - Goals

- Transactional leadership motivates the individual through goals and rewards on the individual level
- Transformational leadership motivates the group through goals and rewards

Practicing the Art of Leadership

As I reflect upon the work of Kegan and Lahey (2001), I realize that the ideas presented closely parallel the work of Chris Argyris (2001). Kegan and Lahey begin with premise that we all have powerful inclinations not to change. They describe this resistance to change as a need to maintain equilibrium, a need that takes us back to the place we were before a change. Margaret Wheatley (1999) called this “self referencing.” This theme presented in Wheatley's work states that human capacity for change and commitment are based on relationships, a connection to new information, and the link to institutional mission. To initiate or sustain change, one must examine one’s core values and reflect on his or her purpose. Wheatley (1999) refers to this as the need for self-reference in the change process and the human need for meaning. Simply stated, leadership must come from the core to be authentic. It is impossible for us to be passionate about something we do not value. Kegan and Lahey , Argyris, and Wheatley see this as a necessary feature of effective leadership.

My leadership theories in use are based upon the ideas outlined by Kegan and Lahey (2001) , Argyris (2001), and Wheatley (1999) and was practiced over the course of this study. My task as an educator is ultimately to produce technically literate, productive members of the technological society in which we live. The educational philosophy I developed as my espoused leadership is put to use in my role as an educator. Based on who I am and what I know at this instant in time, I educate students to survive life in a technological society. As this society evolves, due to pressures from technology, industry, globalization, and economics, mismatch errors occur between what my current theories in use are and what is now required to educate society's citizens as it evolves. This is in essence how my leadership blends into and is the basis of this participatory action research. I currently see a need to better educate all students, and in particular underrepresented students, to enable them to survive life in a technological society, so through action research I attempted to better understand my profession and my practice and sought to improve my practice by exploring new paradigms in computer science education in an effort to present it in a sociocultural light to attempt to draw more women and minorities into the major.

Importance of Reflection

The Hedgehog Concept (Collins, 2000) is a concept that flows from the deep understanding about the intersection of the following three circles. The three circles shown in Figure 17 represent the application of the Hedgehog concept in the context of my leadership. This represents my understanding of my leadership in terms of my passion, what I believe I can be the best at, and what this drives my leadership. I was able to reach this level of understanding through reflection on my actions and my leadership and applying the Hedgehog Concept.

- **What can I be best in the world at?** This standard goes far beyond core competence; just because I possessed a core understanding of computer science education did not mean that I knew all I needed to know to stop the flight of underrepresented students from the major. This provided me with the desire to know all that I could know about this issue and drove my study.
- **What drives my leadership?** To get insight into what drives of my leadership, I searched for the one denominator that had the single greatest impact. Ethics was the denominator that provided the glue to bind this study with my leadership. This is in essence how my leadership blends into and is the basis of this participatory action research. I currently see a need to better educate all students, and in particular underrepresented students, to enable them to survive life in a technological society, so through action research I will attempt better understand my profession and my practice and seek to improve my practice by exploring new paradigms in computer science education in an effort to present it in a sociocultural light to attempt to draw more women and minorities into the major.
- **What am I deeply passionate about.** Passion cannot be manufactured, nor can it be the end result of a motivation effort. I can only discover what ignites my passion and the passions of those around me. My educational philosophy incorporates reflective practice that allows me to understand my core values and purpose beyond simply performing my job. My dissertation was a study of myself and how I can leverage my passions to entice more minorities into computer science.

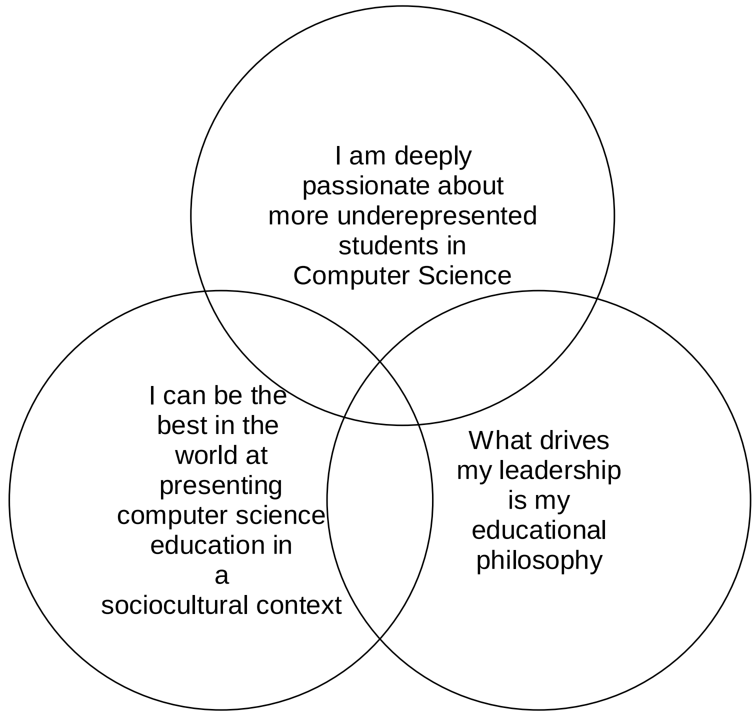

Figure 17. The Hedgehog Concept.

Developing Reflective Practice for CSAR Participants – Online Journal System (OLJS)

It was important for me to use reflective practice to help understand my leadership and myself, and was essential in the success of this project; I also felt that this was essential for students to help them develop a plan for success. The goal of the Online Journal System (OLJS) is to document some of the interactions that influence the knowledge, practice, and motivation of the CSAR participants' experience. The students made journal entries to capture the nature of interactions they had with the PCI faculty, staff, and students. The students noted what prompted the interaction, who was involved, how it took place, what transpired, and the area it pertained to. Additionally, a weblog (Blog) will allow students to interact asynchronously to express their thoughts and feelings about their experiences. The data will be stored in a database and pages (Appendix D) will be available that allow the students to generate various reports sorted on different criteria.

The work of Kegan and Lahey (2001) and Collins (2001) argue that perceptions and motivation for success comes through an understanding of one's core values and passions. Understanding these values and passions is the key to comprehending what is vital and what changes in underlying assumptions may be considered necessary to achieve what is valued as success. Employing reflective practice facilitates a deep understanding of core values and passions and only through its use can one examine and reflect on their purpose. It is impossible for us to be passionate about something we don't value.

Passion is a major factor in success or obtaining things we value. This theme is illustrated in the work Good to Great (Collins, 2001) by the Hedgehog Concept. The Hedgehog Concept is a concept that flows from the deep understanding about the intersection of three circles as illustrated in Figure 18. In the context of this discussion, the intersection of the circles equals a students' success in the CS major. There are three things that lead to success based upon my interpretation of the theory. The first thing is passion, the second thing is education, and the third thing is commitment. In the context of enticing students to succeed in computer science, the Hedgehog Concept can be used to show students a formula for success. Passion by definition is an intense devotion toward something that you enjoy doing. In the computer science profession, one must stay abreast of new technology, only with a passion to learn can one accomplish this. This brings me to the second item on my agenda for success, education. We live a society where one can achieve many levels of success, but this is a highly technical and competitive society. To succeed in society today you must have a college degree and be technologically literate.

The final item on my formula for success is commitment. I like to use the analogy of one being the captain of a boat called "ME", starting the journey on the river of life.

The captain of a boat is responsible for where the boat sails, everything that occurs on the boat, and everyone on the boat. As the captain of the boat "ME", I am responsible for everything that happens on the boat. This means that I am committed to the success of "ME" as I sail on the river of life. Where ever I decide to direct "ME" is where "ME" goes, therefore, "ME" is committed to success and success comes from my passion to learn and my commitment to education. Applying this to the formula for students' success, each individual student is in charge of the boat "YOU". Where "YOU goes in life is all up to the captain of "YOU", therefore as the captain of "YOU", the captain must have a passion to learn and succeed and must be committed to learning through education and "YOU" will sail on a course to success.

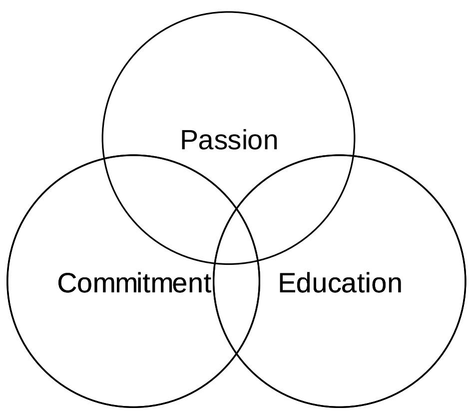

Figure 18. The Hedgehog Concept illustrating the formula for success in the computer science major.

OLJS Student Input

The data retrieved from OLJS shows students' reflective practice in response to what they have learned from planned activities and how they think it has better prepared them to succeed in college. The data indicates that reflection is having an impact on the PCI students' mental models.

- "I learned that when education is the top priority, risks and sacrifices must be made even if they are hard to do or let go."
- "I learned some things I did not know about myself and how I feel during the past week. That I value education on the top of my mind than anything else. And that money is in the second listing."
- "I learned that I am a lot stronger than I thought I was."
- "I learned that if u don't know the history of something you can never truly understand the present."
- "During public speaking I learned that with determination your dreams can come true. I determined that I am truly passionate about my personal mission statement. In my mission statement I focus on what I want to do; I will achieve my goals with determination, communication, and recognition of what I need to do to make my dream turn into a reality."
- "This task helped me to prepare for college because it helped me to recognize that I need to reflect on myself before I can proceed with my goals of being successful and making a beneficial contribution to my community."
- "That I'm a good leader because the whole group gravitated towards me to be the spokesperson."
- "It help me realize not to underestimate the power of my brain"
- "Something I learned from the activities how I can begin to have a paradigm shift. After coming to a standard definition and realizing some of my paradigms, I realized how I can shift them to make myself a better person."
- "I learn a lot of thing from these few days on this program. The first most important is not to take Education for granted because of all the things that was fought over in the past for future generation. Second is as a new generation, it is

our responsibility to keep that opportunity or maintain it from being crumble into segregation of class base on financial status. Our duty is to be involved with politic and help future generation. Third is not to Judge a book by its cover. and many more."

- "I think these wonderful experiences from our activity help us overlook our paradigm or our old belief and maybe change our course to a better understanding of the "real world". Not everything in this world is Just and it a duty of those who is not ignorance to protect those who are ignorant. So over all I think it help us prepare for college in term of study habit but also change our point of view for the better. So far it open me eyes to so many unjust in this world. I have chance to make something good for this community and if I let that chance slip away there maybe won't be another chance like this ever happening again."

In conclusion, the purpose of the OLJS is to introduce the students to reflective practice to better understand themselves, their passions, reshape their mental models, and develop a formula for their success.

First Order Change through Team Learning

Team learning is a state that a group of individuals reach in which their collective intelligence becomes the group's intelligence. To achieve this state of consciousness, the learning team must be versed in discussion and dialogue, the defensive routines and assumptions of the individuals must be suspended for the greater good of the group, there must be a facilitator in the team to guide the group in dialogue and discussion and the learning team must practice the craft of team learning (Senge, 1999).

Teams are made up of individuals that all have their own points of view and intelligence. These individual assumptions are based on what Chris Argyris (2001) calls Model I Theory-in-use, which is a set of beliefs used by people to manage their lives or exercise control. Model I Theories-in-use are protected by defense routines. This takes place on both an individual and group level. Fancy footwork is how an individual or group struggles to maintain control and avoid embarrassment when threats to their theories-in-use are encountered. The threat is avoided and not discussed. What is espoused is not what is meant in actuality. This is done because neither side wants to be embarrassed nor lose the control that each perceives they maintain. This leads to malaise or mediocrity. What is done is for the protection of the individual or group regardless of whether or not it is best for the organization and the theories-in-use are preserved. What happens as the result of the protection of Model I theories-in-use is single loop learning. In single loop learning the core values of an organization loose importance because all that matters is the protection of Model I theories-in-use.

Margaret J. Wheatley (1999) also presents a new way of thinking about how teams are structured and how they function. This new mode of understanding a team is based upon quantum science. In the Newtonian view of a team, it is a closed system that runs on its own accord and is prone to breakdown of the individual parts. The parts are replaced and the machine runs, but the basic design never changes. In the quantum view this is not actually the case; the team is a dynamic system that is constantly changing due to interactions and relationships between the individuals in the team. Senge (1999) refers to this state as a learning team.

Senge (1999) also found for a team to become a learning team, it must practice dialogue and discussion. Through this discourse the individuals interact with each other and their energies become aligned as one. Discussion allows the individual to express and defend their views and ideas, but the underlying purpose of discussion is to win. Discussion is a necessary component of a learning team for it prevents the individual from becoming lost in the group, but if it is not checked it is self defeating because defense routines will be activated to protect the individuals' underlying assumptions and the group remains in single loop mode. Dialogue is where the group goes beyond individual understanding and reaches a shared understanding. In order for dialogue to take place, underlying assumptions and defensive routines must be suspended and the team members must view each other in a new light as colleagues. Dialogue is not a discourse where winning is the end result, but where the group is focused on achieving a new level of understanding. To engage in dialogue and not discussion a learning team must have a facilitator that is skilled in discussion and dialogue. The role of the facilitator is to ensure that there is a constant flow of meanings between the individuals of the team and to maintain a balance between discussion and dialogue. The facilitator also is needed to deal with conflict and defense routines (Senge, 1990; Senge 1999).

This is how I practiced my leadership during this study. I acted as the facilitator in an attempt to understand, expose, and open to change the mental models of the team. My leadership served as the catalyst for change by attempting to put Model II and team learning into practice. Argyris (2001) states that in order achieve double loop learning, the team must re-evaluate the core values and discuss what was previously not discussed, even if it means threatening theories-in-use. Through Model II actions and my leadership, the underlying assumptions were ascertained and made open to change.

The components of a learning team that we have addressed are without benefit unless the team practices the craft of team learning. Through practice the team becomes experienced in discussion and dialogue and learns together. To practice team learning, there must be practice sessions where the teams tackle real and complex realities, but it must be a safe environment with rules. The first rule is that assumptions must be suspended; this is to prevent the activation of defensive routine to protect theories-in-use. The second rule must be that every team member views other team members as their colleagues, this eliminates any hierarchical threats, and the last rule is that the team members must have the spirit of inquiry to gain understanding beyond their own beliefs (Senge, 1990; Senge, 1999). In summary, a team can only become a learning team through the following components: discussion and dialogue, suspended defense routines and assumptions, a facilitator to guide the group in dialogue and discussion, to resolve conflict, and to prevent the activation of defense routines, and the learning team must practice the craft of team learning.

I still have much to learn in all areas of my leadership. I have become a reflective practitioner who embraces not only transformational/ethical leadership, but also reflective practice. I see the two as working together hand and hand. I must constantly reflect, not only on the continuing process of change, growth, and development, but how my leadership is intertwined within each of the three. I see the opportunities that come from my mistakes, and will use these to practice double loop learning. I continue to embrace what drives my leadership, grounded in my interpretation of the Hedgehog Concept, my passions and commitment. I am using the knowledge that I have gathered over the course of my doctoral work to plan for the future. I will continue to seek out new paradigms to meet my goal as an educator, to educate and prepare students to survive and be productive members of the society in which we live.

Future Considerations

During the 2000 to 2006 time period, enrollment in computer science at Rowan University experienced a significant decline. Total enrollment dropped 39% over this period and the number of underrepresented students declined. Nonwhite students were 29% of the computers science majors in 2000 and declined to 21% of the computer science majors in 2006. Additionally, the female population, exclusive of ethnicity, of the computer science major declined from 23% to 5% over the same period. This decline follows a nationwide downward trend for women in computer science and a level or slightly upward trend for underrepresented minorities (http://www.nsf.gov/statistics/seind06).

Facilitating Academic Triumph by Providing an Integrated Pipeline Experience (FATPIPE) is a pilot pipeline program that consists of modules that are geared towards facilitating increased enrollment, retention, and success of students in Computer Science at Rowan University. The learning community, Learning in Bits and Bytes (LiBBy) is designed towards helping students adjust to the first year of college life, the Computer Science Alternate Route (CSAR) program is a two pronged program. First, CSAR is designed to attract, retain, and graduate more women and minorities to the computer science major, and second, the overall goal of CSAR is to increase enrollment in computer science. The role that K-12 and 2 year educational institutions will play filling the pipeline is crucial. The long term success of FATPIPE depends upon a partnership between higher education, K-12, and 2 year institutions to extend FATPIPE outside the walls of higher education and reach the children at an early stage to ensure the pipeline remains full in the future. Additionally, to ensure a continuum of graduates able to become future role models, mentors, educators, and scientist, FATPIPE must also be extended to graduate institutions. Partnerships with graduate institutions are also vital to the long-term success of FATPIPE. The success of these initiatives will empower the students to become future educators, researchers, and workers and to provide mentors and role models for future generations.

There is an unprecedented need for more representation of underrepresented groups in math, science, and engineering, as well as an increased awareness of its vital importance for sociocultural and economic development, and for building the future. Future generations need to be equipped with new skills, knowledge, and ideals**.** Higher education is faced with meeting these needs while at the same time, being challenged by new opportunities relating to technologies that are improving the ways in which knowledge can be produced, managed, disseminated, accessed, and controlled. Equitable access to these technologies should be ensured at all levels of education systems through new recruitment methods that aggressively target the underrepresented student population.

Discussion and Conclusions

This action research study involved developing an understanding of the reasons for the flight of underrepresented students from computer science, and developing a solution that sought to address the problem in an attempt to answer the research questions that were put forth in the beginning of this study. How can my leadership improve interest/enrollment in computer science education at Rowan University for underrepresented students? This question has been answered by the successful pilot of FATPIPE. The groundwork was laid for FATPIPE through my leadership which started with my understanding of the issues facing underrepresented students and their flight from computer science. The data that emerged from this study supported the fact that there are assumptions in the students' mental models that would play a large part on the decision of computer science as a major. The analysis revealed a general lack of understanding about the major and possible apprehension of ethnic, gender, and social isolation. This was reflected in the decisions of the students that had made a decision on which major to pursue. The majority chose majors that involve a great deal of social interaction and diversity. What these finding indicate is a flight of underrepresented students from computer science. The issues that must be overcome to address this problem are providing students with the means of understanding computer science and providing more mentors and role models in the field. The latter cannot be accomplished without enticing more underrepresented students to choose computer science as a major.

Can raising awareness about computer science and providing an alternate path into computer science have an impact on underrepresented students' choice of computer science as their major? The answer to this question is yes. The trends that emerged from examining the enrollment data at Rowan University in the context of race and ethnicity indicated that this population of the student enrolling in Rowan University showed a large decrease in the female population choosing computer science, even though they make up the largest percentage of students. This trend follows worldwide trends showing women in general shying away from math, science, and engineering disciplines making them more at risk than minority students, requiring greater efforts to entice them into these fields, as well as increased activities to attract minorities as well if they are to be equipped to survive life in a technological society.

"What can be done to start and address this problem?" As an educator teaching computer science, I feel obligated to prepare not only underrepresented students, but all students to be technologically literate. My leadership was the driving force behind my entire study and the development of FATPIPE. The down turn in computer science enrollment indicates that students from all groups are shying away from the computer science major. With fewer students in the pipeline, there will be fewer students to fulfill the roles of educators, researchers, workers, mentors, and role models in the future. The understanding of my leadership has opened my eyes to my task as an educator. First I must entice more students to choose computer science as a major, and secondly, I must prepare them to be technologically literate. The first task was addressed as I lead a collaborative effort to design and pilot FATPIPE in order to entice more underrepresented students into the computer science major. The second task involved interacting with the incoming EOF/MAP cohort in order to raise their awareness about computer science in a sociocultural context that allows students to construct meaningful knowledge and to overcome race and gender threats that drive students away from the computer science major.

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Appendix A

Student Survey Instrument

Summer 2006

To the respondent: ***This survey is voluntary. We appreciate your cooperation in answering the questions. We are interested in your insights, observations, and comments about your choice of major at Rowan University. The information will be used to complete the requirements of the Educational Leadership doctoral program at Rowan University, and may be part of a presentation or publication. Your individual responses will be held in strictest confidence. Thank you for your cooperation.***

1) Sex (Check one)

M ______
F ______

2) Program (Check one)

EOF ________
MAP ________
Not Sure ________

3) Race/Ethnicity (Check all that apply)

African American/Black ___________
American Indian/Native American ___________
Asian American/Pacific Islander ___________
Hispanic/Latino(a) ___________
White/Caucasian (Non-Hispanic) ___________

4) What are your parents' highest levels of education? (Check only one for each parent)

Level of Education	Mother	Father
Elementary School	______	______
Some high school	______	______
High school diploma/GED	______	______
Some college (No degree)	______	______
Associate's Degree (2 yr. degree)	______	______
Bachelor's Degree (4 yr. degree)	______	______
Master's Degree	______	______
Advanced Degree (Dr., Lawyer, PhD/EdD)	______	______
Unknown	______	______

5) Who do you live with? (Check one)

Mother____ Father____ Both Parents_______
Grandparent(s)/Other relative____ Guardian_____
Friends______Independently____

6) What year did you graduate high school? (Check one)

2006____ 2005____ 2004____ 2003 or earlier____

7) In high school, how many computer science or programming courses did you take? (Check one)

None____ 1-3____ 4 - 6____ 7 – 10____ 10 or more____

8) What math courses did you take in high school? (Check all that apply)

Pre-algebra____ Algebra I____ Geometry____ Algebra II____

Pre-calculus____ Calculus________ Other____ (Course name _______________)

9) What is the highest educational degree you expect to obtain? (Check one)

Bachelor's Degree (4 yr. degree) ______
Master's Degree ______
M.D. (Medical Doctor) ______
J.D. (Lawyer) ______
Ph.D./Ed.D. ______
Not sure ______

10) How many years do you think it would take you to get a Bachelor's degree? (Check one)

Less than 4 yrs.____ 4 years____ 5 years____ 6 years____

6 years or more____

11) Have you decided upon a college major? (Check one)

Yes ____
No ____

12) If you have chosen a major, what is your choice? (Write in your choice)

Major ___________________

13) If you have not chosen a major, what do you think your choice will be? (Write in your choice)

Major ___________________

14) Do you own a computer or laptop? (Check one)

Yes ____
No ____

15) Do you own a PlayStation, Xbox, Sega Genesis, Atari, or Nintendo video game console? (Check one)

Yes ____
No ____

16) Do you plan to bring a computer or laptop with you to college? (Check one)

Yes ____
No ____

17) If you do not own a computer please check the primary reason (Check all that apply)

Cost ____
I am not interested in computers ____
Owning a computer is not a priority ____
I don't need a computer; I have a video game ____

Cognitive

Please check one response for each statement:	Strongly Disagree	Disagree	Agree	Strongly Agree
I have a strong math background.				
I like using logic to solve problems.				
Computer science is not for me because I do not have a strong math background.				
I understand what computer scientists do.				
I have thought about computer science as a major				
The first time I used a computer was in high school.				
I think computers make my life easier.				
I feel that I am academically prepared to handle computer science as a major.				
I feel that I am academically prepared to handle the college curriculum.				
I feel that I have a strong computer background.				

Societal

Please check one response for each statement:	Strongly Disagree	Disagree	Agree	Strongly Agree
I will need computer skills for my job/career after college.				
Minorities and women are equipped to succeed in computer science and math.				
Computer science majors have a social life.				
Computer science is only for white males.				
Most of my friends choose majors other than computer science.				
Computer science majors fit in with other non computer science majors.				
I see very few minorities and women on science channels like The Discovery Channel.				
Computer scientists work with machines instead of working with people.				
A computer science graduate can only get a job as a word processor or programmer.				

Biological

Please check one response for each statement:	Strongly Disagree	Disagree	Agree	Strongly Agree
I was encouraged to learn computer science.				
I never had an interest is computer science.				
I spend more time talking to people on computers than in person.				
I am confident in my ability to work with computers.				
I wish I had learned more about computers in high school.				
If I choose computer science as a major I will no longer fit in with my friends.				
I think females would succeed in a major that involves science or math.				
I think males should choose a major that involves math or science.				
My parents do not want me to choose computer science as my major.				
It is ok for women to choose computer science as a major.				

Appendix B

Online Leadership Inventory Systems (OLIS) Screens

Online Leadership Inventory System

OLIS Login Screen

Enter your Rowan user details

username [ ]

password [ ]

Submit

If you are working on a public computer
do not save your username or password
if prompted by your web browser

Online Leadership Inventory System

OLIS Start Screen

Hi robinsonj

The OLIS is designed to serve as a single point to enter data related to a research project and to one's leadership. The system allows one to enter data gathered from interviews and observations, as well as personal reflection and thoughts as one would in a written journal. All of the information is stored in a database and may be viewed and retrieved in the form of reports.

Click Here for Usage License and Privacy Policy

What Activity Would You Like to Perform?

Journal Input

Observation Input

Interview Coding

Upload Files

View Files

View All Files

Generate Reports

Exit OLIS

O.L.I.S. Online Leadership Inventory System.
This is a leadership/research inventory and data management program.

**/
Privacy Statement and Terms of Use

Introduction

The site editor takes your right to privacy seriously, and wants you to feel comfortable using this web site. This privacy policy deals with personally-identifiable information (referred to as "data" below) that may be collected by this site. This policy does not apply to other entities that are not owned or controlled by the site editor, nor does it apply to persons that are not employees or agents of the site editor,
or that are not under the site editor's control. Please take time to read this site's Terms of use.

1. Collection of data

Registration for an account on this site requires a valid Rowan University user account and is governed by the policies applicable for proper use of Rowan University's Network services.
http://www.rowan.edu/toolbox/documentation/

2. Use of data

Any data stored on this system is for educational purposes only.

3. Cookies

No cookies are maintained on this site or any of the data

4. Editing or deleting your account information

Your account information is valid only during your active enrollment as a Rowan University student or employee.

6. Changes to this privacy policy

Changes may be made to this policy from time to time and will be posted here.

7. NO GUARANTEES

While this privacy policy states standards for maintenance of data, and while efforts will be made to
meet the said standards, the site editor is not in a position to guarantee compliance with these standards. There may be factors beyond the site editor's control that may result in disclosure of data. Consequently, the site editor offers no warranties or representations as regards maintenance or non-disclosure of data.

8. Contact information

Online Leadership Inventory System

OLIS Journal Input Screen

Click Here For Help

Was this a typical day?

○: yes
○: no

If No, Why was this not a typical day?

What did you do today that was related to you leadership?

What prompted this task/activity related to your project or leadership?

Who was involved in the task/activity and what were their roles?

How did the task/activity take place?

What transpired during the task/activity?

Online Leadership Inventory System

OLIS Observation Input Screen

Click Here For Help

What did you observe today?

Where did the observation take place?

Describe the observation environment

What were the events that occurred (beginning, middle, end)?

Enter field notes, i.e. quotes from participants, non verbal communication, what was seen/observed, what questions remain, how can my observations be improved, was this meaningful/useful data

Check your input carefully before you click on the Submit button!

Submit Input | Clear the Form

Online Leadership Inventory System

OLIS Interview Input Screen

Click Here For Help

Enter theme that emerged from your interviews?

Enter Interview 1 data related to this theme?

Enter Interview 2 data related to this theme?

Enter Interview 3 data related to this theme?

Enter Interview 4 data related to this theme?

Is it possible that I influenced the data in any way?

Did I get the data needed to answer my research questions?

Online Leadership Inventory System

OLIS File Upload Screen

Click Here For Help

- ◯ Journal File
- ◯ Interview File
- ◯ Observation File

Please choose a file: [ ] Choose...

Upload

Online Leadership Inventory System

OLIS File Download Screen

Click Here For Help

Directory of robinsonj's Files

File Name	File Type	Date Uploaded	Time Uploaded	
1003022855.1119196884.jpg	journal	04/13/2007	10:21pm	[Delete]
1006420553.1120083435.jpg	journal	04/13/2007	10:21pm	[Delete]
1006695177.1120753943.jpg	journal	04/13/2007	10:21pm	[Delete]
1009485801.1120190684.jpg	journal	04/13/2007	10:21pm	[Delete]
130245.aspx.htm	journal	04/09/2007	11am	[Delete]
academic standing policy march07 (2).pdf	project	04/09/2007	6:08pm	[Delete]
Academic Transcript_Sondria.pdf	journal	04/10/2007	10:58am	[Delete]
accesspoints.txt	journal	5/11/2007	6:39am	[Delete]
ANSI character table.html	journal	04/09/2007	11am	[Delete]
ASP.NET and VB.pdf	journal	04/08/2007	11am	[Delete]
asset-29775.jpg	journal	04/13/2007	10:21pm	[Delete]
bass_sticker.pdf	journal	06/02/2007	1:09am	[Delete]
C++ Stat Libs.txt	project	04/09/2007	6:08pm	[Delete]
CCLIProposalDraft2doc.doc	journal	07/10/2007	8:39am	[Delete]
ch08.rar	journal	04/25/2007	3:34	[Delete]
checkofflist_john.doc	journal	04/10/2007	10:58am	[Delete]
classes.rar	observation	04/14/2007	6:28am	[Delete]
complex.CPP	journal	04/09/2007	12:10am	[Delete]
con2prt.exe	journal	04/28/2007	7:12am	[Delete]
Creek.jpg	journal	04/13/2007	10:21pm	[Delete]
CS_Grad_req.xls	project	04/09/2007	6:08pm	[Delete]
dawson.pdf	ITP	05/13/2007	11:26am	[Delete]
Document1.txt	journal	004/08/2007	11am	[Delete]

Online Leadership Inventory System

OLIS Reports

Generate a report showing journal activities sorted by date:

[Generate Report]

[Save Report to Myfiles]

[View All Data]

Generate a report showing interview activities sorted by date:

[Generate Report]

[Save Report to Myfiles]

[View All Data]

Generate a report showing observation activities sorted by date:

[Generate Report]

[Save Report to Myfiles]

[View All Data]

Click the button below if you wish to return to OLIS start screen

[Start Screen]

Click the button below if you wish to exit OLIS

[Exit OLIS]

Appendix C
CSAR Course Sequences

CSAR Fast Track Course Sequence

FIRST SEMESTER			SECOND SEMESTER	
Introduction to Programming	3		Intro to Object Oriented Progr. (RS)*	4
College Composition I	3		College Composition II	3
Pre-Calculus	4		Calculus I	4
General Education course (ACE bank)	3		General Education course (HHL Literature (LIT) course if not already taken)	3
General Education course ++	3		Discrete Structures	3
TOTAL	16		TOTAL	17
THIRD SEMESTER			FOURTH SEMESTER	
Foundations of Computer Science	3		Data Structures and Algorithms	4
Calculus II	4		Linear Algebra	3
Obj. Oriented Prog. & Data Abstractn	4		Lab Science Choice **	4
Computer Lab Techniques +++	3		Public Speaking	3
			Computer Organization	3
TOTAL	14		TOTAL	17
FIFTH SEMESTER			SIXTH SEMESTER	
Design & Analysis of Algorithms	3		Principles of Digital Computers and Digital Computer Laboratory	4
Operating Systems	3		CS restricted elective	3
Computers and Society (Writing Intensive (WI))[+]	3		Principles of Software Engineering	3
Lab Sequence 1 **	4		Lab Sequence 2 **	4
Probability & Statistics I (if not taken, or General Ed. (HHL LIT) course	3		Programming Languages	3
TOTAL	16		TOTAL	17
SEVENTH SEMESTER			EIGHTH SEMESTER	
Computer Science Senior Project	3		CS Restricted elective	3
CS restricted elective	3		General Education course++	3
CS restricted elective	3		General Education course (HHL bank) Rowan Seminar (RS) course if not already taken)	3
General Education course (SBS Bank) (Multicultural/Global Studies (M/G) course)	3		Free Elective (if needed to complete 120 credit hours requirement)	3
Free Elective	3			
TOTAL	15		TOTAL	Up to 12

CSAR Slow Track Course Sequence with < B+ in Introduction to Programming

FIRST SEMESTER			SECOND SEMESTER	
Introduction to Programming	3		Introduction to Programming	3
College Composition I	3		College Composition II	3
Pre-Calculus	4		Calculus I	4
General Education course (ACE bank)	3		Discrete Structures	3
General Education course ++	3			
TOTAL	16		TOTAL	13
THIRD SEMESTER			FOURTH SEMESTER	
Intro to Object Oriented Progr. (RS)*	4		Foundations of Computer Science	3
Calculus II (Linear Algebra, if Calc. II was taken)	4		Linear Algebra	3
General Education course (HHL Literature (LIT) course if not already taken)	3		Computer Lab Techniques +++	3
General Education course (HHL bank) Rowan Seminar (RS) course if not already taken)	3		Obj. Oriented Prog. & Data Abstractn	4
TOTAL	14		TOTAL	13
FIFTH SEMESTER			SIXTH SEMESTER	
Data Structures and Algorithms	4		Design & Analysis of Algorithms	3
Computer Organization	3		Operating Systems	3
Lab Science Choice **	4		Computers and Society (Writing Intensive (WI))[+]	3
Probability & Statistics I (if not taken, or General Ed. (HHL LIT) course	3		Lab Sequence 1 **	4
TOTAL	14		TOTAL	13
SEVENTH SEMESTER			EIGHTH SEMESTER	
Lab Sequence 2 **	4		Principles of Digital Computers and Digital Computer Laboratory	3
Programming Languages	3		CS restricted elective	3
Principles of Software Engineering	3		General Education course (SBS Bank) (Multicultural/Global Studies (M/G) course)	3
Public Speaking	3		General Education course++	3
				3
TOTAL	13		TOTAL	Up to 12
NINTH SEMESTER			TENTH SEMESTER	
Computer Science Senior Project	3		CS Restricted elective	3
CS restricted elective	3		Free Elective (if needed to complete 120 credit hours requirement)	3
CS restricted elective	3			
Free Elective	3			
TOTAL	12		TOTAL	UP TO 6

CSAR Slow Track Course Sequence with <= C in Pre-Calculus and < B+ in Introduction to Programming

FIRST SEMESTER		SECOND SEMESTER	
Introduction to Programming	3	Pre-Calculus	4
College Composition I	3	College Composition II	3
Pre-Calculus	4	Introduction to Programming	3
General Education course (ACE bank)	3	General Education course (HHL Literature (LIT) course if not already taken)	3
General Education course ++	3		
TOTAL	16	TOTAL	13
THIRD SEMESTER		FOURTH SEMESTER	
Calculus I	4	Calculus II (Linear Algebra, if Calc. II was taken)	4
Discrete Structures	3	Foundations of Computer Science	3
Intro to Object Oriented Progr. (RS)*	4	Computer Lab Techniques +++	3
General Education course (HHL bank) Rowan Seminar (RS) course if not already taken)	3	Obj. Oriented Prog. & Data Abstractn	4
TOTAL	14	TOTAL	13
FIFTH SEMESTER		SIXTH SEMESTER	
Data Structures and Algorithms	4	Design & Analysis of Algorithms	3
Computer Organization	3	Operating Systems	3
Lab Science Choice **	4	Computers and Society (Writing Intensive (WI))[+]	3
Linear Algebra	3	Probability & Statistics I (if not taken, or General Ed. (HHL LIT) course	3
TOTAL	14	TOTAL	12
SEVENTH SEMESTER		EIGHTH SEMESTER	
Lab Sequence 1 **	4	Principles of Digital Computers and Digital Computer Laboratory	3
Programming Languages	3	CS restricted elective	3
Principles of Software Engineering	3	Lab Sequence 2 **	4
Public Speaking	3	General Education course++	3
TOTAL	13	TOTAL	13
NINTH SEMESTER		TENTH SEMESTER	
Computer Science Senior Project	3	CS Restricted elective	3
CS restricted elective	3	General Education course (SBS Bank) (Multicultural/Global Studies (M/G) course)	3
CS restricted elective	3	Free Elective (if needed to complete 120 credit hours requirement)	3
Free Elective	3		
TOTAL	12	TOTAL	UP TO 9

CSAR Slow Track Course Sequence with <= C in Pre-Calculus

FIRST SEMESTER			SECOND SEMESTER	
Introduction to Programming	3		Pre-Calculus	4
College Composition I	3		College Composition II	3
Pre-Calculus	4		Intro to Object Oriented Progr. (RS)*	4
General Education course (ACE bank)	3		General Education course (HHL Literature (LIT) course if not already taken)	3
General Education course ++	3			
TOTAL	16		TOTAL	14
THIRD SEMESTER			FOURTH SEMESTER	
Calculus I	4		Calculus II (Linear Algebra, if Calc. II was taken)	4
Discrete Structures	3		Foundations of Computer Science	3
Obj. Oriented Prog. & Data Abstractn	4		Computer Lab Techniques +++	3
General Education course (HHL bank) Rowan Seminar (RS) course if not already taken)	3		General Education course (SBS Bank) (Multicultural/Global Studies (M/G) course)	3
TOTAL	14		TOTAL	13
FIFTH SEMESTER			SIXTH SEMESTER	
Data Structures and Algorithms	4		Design & Analysis of Algorithms	3
Computer Organization	3		Operating Systems	3
Lab Science Choice **	4		Computers and Society (Writing Intensive (WI))+	3
Linear Algebra	3		Probability & Statistics I (if not taken, or General Ed. (HHL LIT) course	3
TOTAL	14		TOTAL	12
SEVENTH SEMESTER			EIGHTH SEMESTER	
Lab Sequence 1 **	4		Principles of Digital Computers and Digital Computer Laboratory	3
Programming Languages	3		CS restricted elective	3
Principles of Software Engineering	3		Lab Sequence 2 **	4
Public Speaking	3		General Education course++	3
TOTAL	13		TOTAL	13
NINTH SEMESTER			TENTH SEMESTER	
Computer Science Senior Project	3		CS Restricted elective	3
CS restricted elective	3		Free Elective (if needed to complete 120 credit hours requirement)	3
CS restricted elective	3			
Free Elective	3			
TOTAL	12		TOTAL	UP TO 6

CSAR Slow Track Course Sequence with <= C+ in Pre-Calculus and <= B+ in Introduction to Programming

FIRST SEMESTER			SECOND SEMESTER	
Introduction to Programming	3		Calculus I	4
College Composition I	3		College Composition II	3
Pre-Calculus	4		Intro to Object Oriented Progr. (RS)*	3
General Education course (ACE bank)	3		General Education course (HHL Literature (LIT) course if not already taken)	3
General Education course ++	3			
TOTAL	16		TOTAL	13
THIRD SEMESTER			FOURTH SEMESTER	
Calculus II (Linear Algebra, if Calc. II was taken)	4		Linear Algebra	4
Discrete Structures	3		Foundations of Computer Science	3
Obj. Oriented Prog. & Data Abstractn	4		Computer Lab Techniques +++	3
General Education course (HHL bank) Rowan Seminar (RS) course if not already taken)	3		Data Structures and Algorithms	4
TOTAL	14		TOTAL	14
FIFTH SEMESTER			SIXTH SEMESTER	
Design & Analysis of Algorithms	4		Lab Sequence 1 **	4
Computer Organization	3		Operating Systems	3
Lab Science Choice **	4		General Education course++	3
Computers and Society (Writing Intensive (WI))[+]	3		Probability & Statistics I (if not taken, or General Ed. (HHL LIT) course	3
TOTAL	14		TOTAL	13
SEVENTH SEMESTER			EIGHTH SEMESTER	
Lab Sequence 2 **	4		Principles of Digital Computers and Digital Computer Laboratory	3
Programming Languages	3		CS restricted elective	3
Principles of Software Engineering	3		Free Elective	4
Public Speaking	3		General Education course (SBS Bank) (Multicultural/Global Studies (M/G) course)	3
TOTAL	13		TOTAL	13
NINTH SEMESTER			TENTH SEMESTER	
Computer Science Senior Project	3		CS Restricted elective	3
CS restricted elective	3			
CS restricted elective	3			
Free Elective	3			
TOTAL	12		TOTAL	3

Appendix D

Online Journal Systems (OLJS) Screens

Online Journal System

OLJS Login Screen

Enter your Rowan user details

username

password

Submit

If you are working on a public computer
do not save your username or password
if prompted by your web browser

Download the system manual here

Online Journal System

OLJS Start Screen

Hi robinsonj

The OLJS is designed to serve as a single point to enter
data related to your summer experience in the PCI Program.
The system allows one to enter data and thoughts as
one would in a written journal. All of the information is stored
in a database and may be viewed and retrieved in the form of reports.

Click Here for Usage License and Privacy Policy

What Activity Would You Like to Perform?
PCI Basic Skills Assignment

PCI Blog

Journal Input

Upload Files

View Files

View All Files

View Wk1 Assignments

Generate Reports

Exit OLJS

O.L.J.S. Online Journal System.
This is a leadership/research inventory and data management program.

***/

Privacy Statement and Terms of Use

Introduction

The site editor takes your right to privacy seriously, and wants you to feel comfortable using this web site. This privacy policy deals with personally-identifiable information (referred to as "data" below) that may be collected by this site. This policy does not apply to other entities that are not owned or controlled by the site editor, nor does it apply to persons that are not employees or agents of the site editor, or that are not under the site editor's control. Please take time to read this site's Terms of use.

1. Collection of data

Registration for an account on this site requires a valid Rowan University user account and is governed by the policies applicable for proper use of Rowan University's Network services.
http://www.rowan.edu/toolbox/documentation/

2. Use of data

Any data stored on this system is for educational purposes only and may be used for research purposes.

3. Cookies

No cookies are maintained on this site or any of the data

4. Editing or deleting your account information

Your account information is valid only during your active enrollment as a Rowan University student or employee.

6. Changes to this privacy policy

Changes may be made to this policy from time to time and will be posted here.

7. NO GUARANTEES

While this privacy policy states standards for maintenance of data, and while efforts will be made to
meet the said standards, the site editor is not in a position to guarantee compliance with these standards. There may be factors beyond the site editor's control that may result in disclosure of data. Consequently, the site editor offers no warranties or representations as regards maintenance or non-disclosure of data.

8. Contact information

PCI BLOG

User: robins57

Date: 06/29/2007

Time: 8:42am

User Input: this is a test

User: miller5u

Date: 07/09/2007

Time: 18:35pm

User Input: ROWAN IS AWESOME!!!!!!!!!

User: kenned21

Date: 07/10/2007

Time: 18:18pm

User Input: To all the guys who have big t-shirts they are not allowed to wear... Come for a \"T-party\"! Turn your t-shirts into stylishly appropriate attire!! I have all the sewing supplies (except a sewing machine). If your not good at sewing, don\'t worry, many of the projects I have a no-sew. All you need are scissors! If you have any questions ask Kae Lani Kennedy in room 340 on the B side. But sometimes I\'m in room 164 which is also on the B side. It\'s not limited to just the guys!!! Girls! Three tiny T-shirts can turn into one beautiful skirt (past the fingertips of course)! It\'s T-shirt alteration and it\'s sweeping the nation! Generation T!

User: baezw24

Date: 07/10/2007

Time: 18:32pm

User Input: You rock!!! I can see you right now.

User: goycoh48

Date: 07/10/2007

Time: 18:35pm

Online Journal System

OLJS Journal Input Screen

Click Here For Help

What task/activity were you involved in today?

Who was involved in the task/activity and what were their roles?

How did the task/activity take place?

What transpired during the task/activity?

What percentage of your day was spent on the following tasks/activities?

Normal PCI tasks/activities: %

Non PCI tasks/activities: %

Time spent organizing your thoughts: %

Time spent thinking about what you learned: %

What did you learn about yourself during the task/activity?

How do you think this task/activity helped to prepare you for college?

Online Journal System

OLJS File Upload Screen

Click Here For Help

Please choose a file: [ ] Choose...

Upload

Online Journal System

OLJS File Download Screen

Click Here For Help

Directory of robinsonj's Files

File Name	File Type	Date Uploaded	Time Uploaded	
1003022855.1119196884.jpg	journal	04/13/2007	10:21pm	[Delete]
1006420553.1120083435.jpg	journal	04/13/2007	10:21pm	[Delete]
1006695177.1120753943.jpg	journal	04/13/2007	10:21pm	[Delete]
1009485801.1120190684.jpg	journal	04/13/2007	10:21pm	[Delete]
130245.aspx.htm	journal	04/09/2007	11am	[Delete]
academic standing policy march07 (2).pdf	project	04/09/2007	6:08pm	[Delete]
Academic Transcript_Sondria.pdf	journal	04/10/2007	10:58am	[Delete]
accesspoints.txt	journal	5/11/2007	6:39am	[Delete]
ANSI character table.html	journal	04/09/2007	11am	[Delete]
ASP.NET and VB.pdf	journal	04/08/2007	11am	[Delete]
asset-29775.jpg	journal	04/13/2007	10:21pm	[Delete]
bass_sticker.pdf	journal	06/02/2007	1:09am	[Delete]
C++ Stat Libs.txt	project	04/09/2007	6:08pm	[Delete]
CCLIProposalDraft2doc.doc	journal	07/10/2007	8:39am	[Delete]
ch08.rar	journal	04/25/2007	3:34	[Delete]
checkofflist_john.doc	journal	04/10/2007	10:58am	[Delete]
classes.rar	observation	04/14/2007	6:28am	[Delete]
complex.CPP	journal	04/09/2007	12:10am	[Delete]
con2prt.exe	journal	04/28/2007	7:12am	[Delete]
Creek.jpg	journal	04/13/2007	10:21pm	[Delete]
CS_Grad_req.xls	project	04/09/2007	6:08pm	[Delete]
dawson.pdf	ITP	05/13/2007	11:26am	[Delete]
Document1.txt	journal	004/08/2007	11am	[Delete]

Online Journal System

OLJS Reports

Generate a report activities sorted by date:

Generate Report

Save Report to Myfiles

View All Data

Click the button below if you wish to return to OLJS start screen

Start Screen

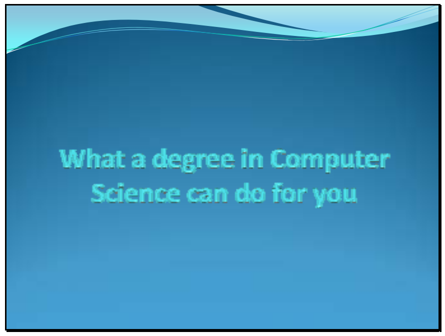
Click the button below if you wish to exit OLJS

Exit OLJS

Appendix E

Computer Science Awareness Raising Presentation

Slide 1



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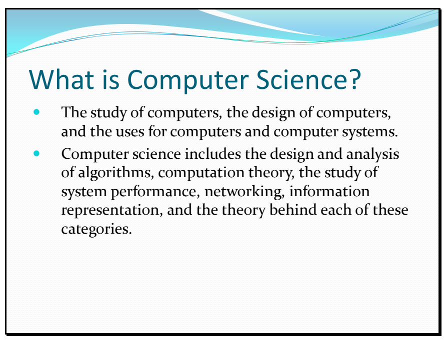

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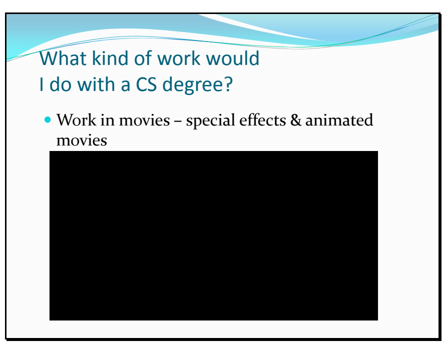

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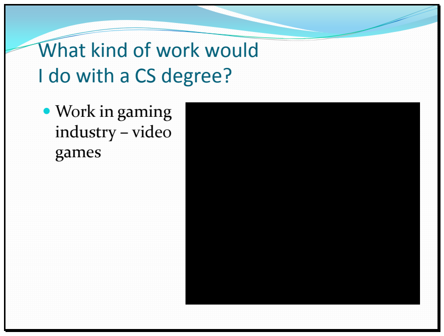

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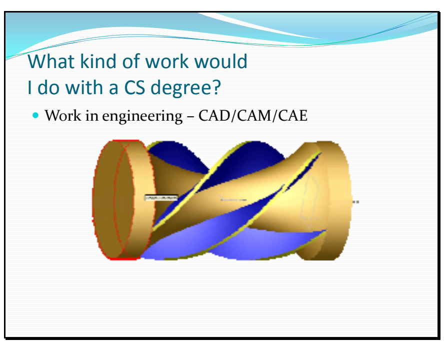
Slide 6



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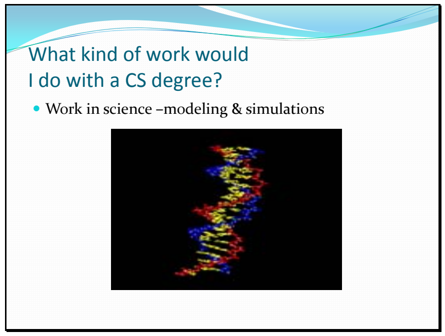

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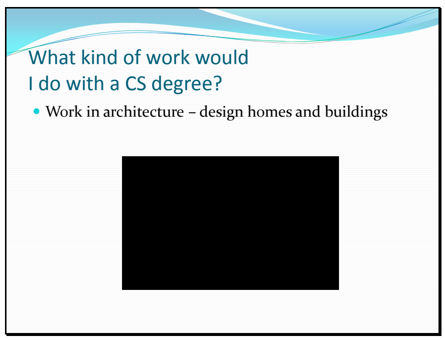

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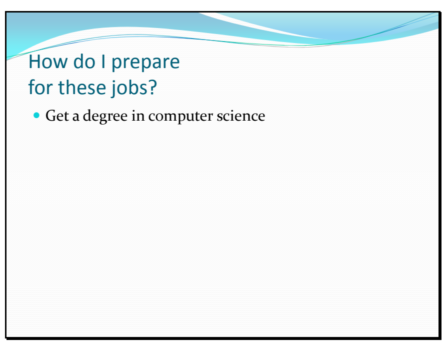

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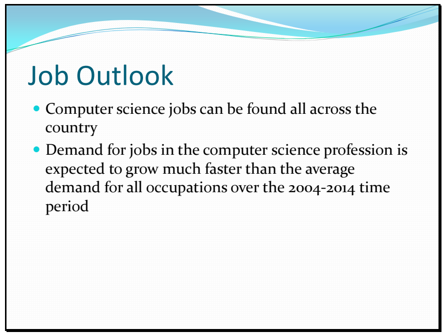

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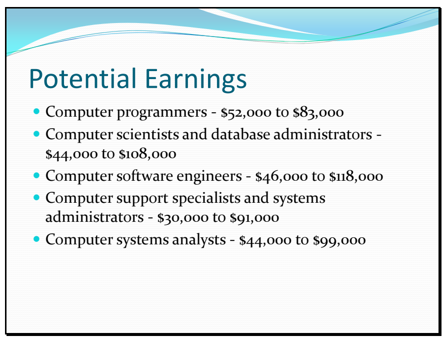

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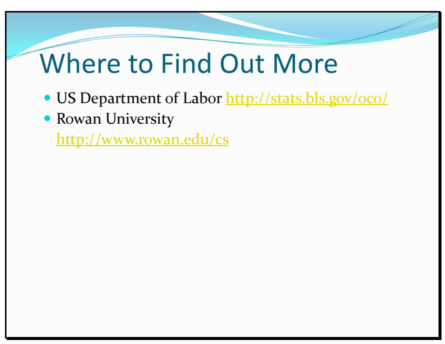

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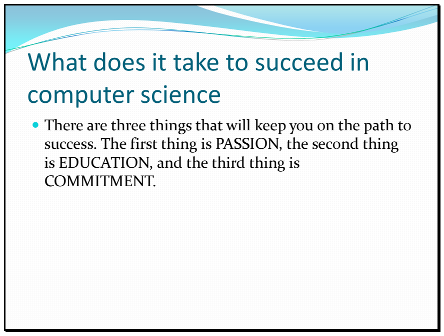

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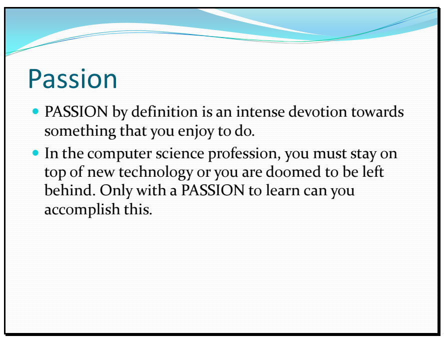

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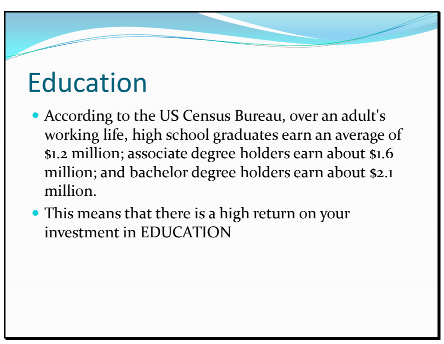

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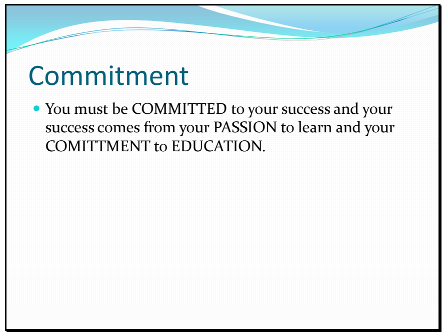

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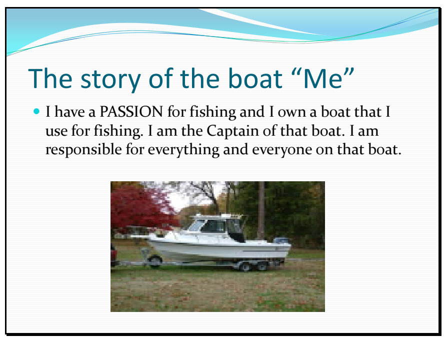

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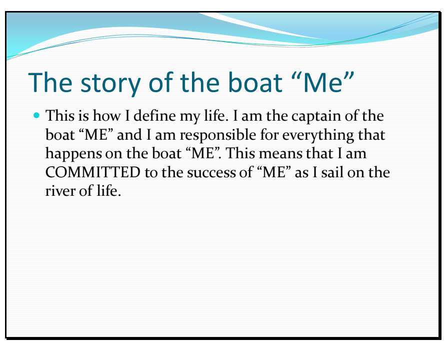

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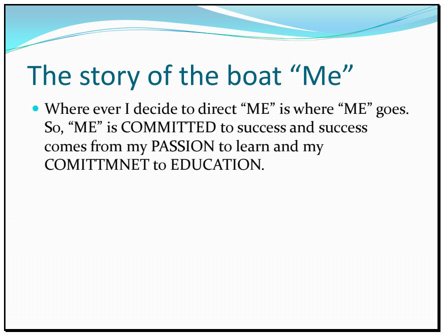

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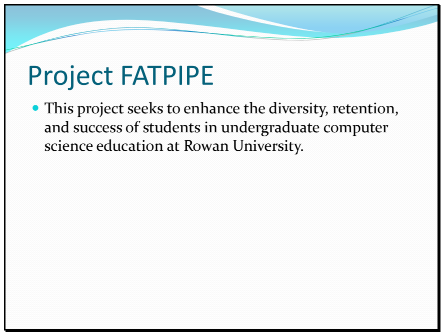

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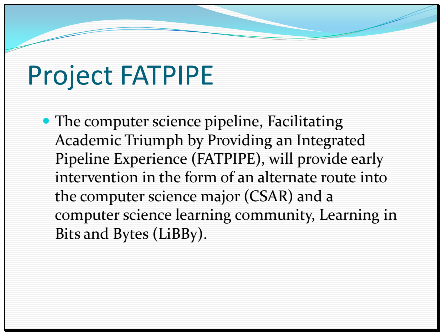

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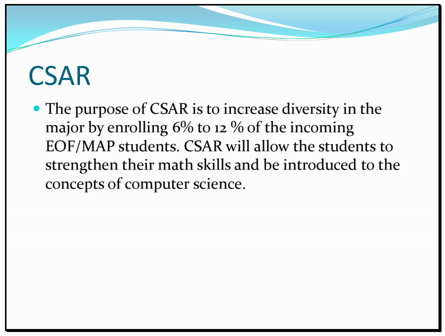

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