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ABSTRACT

This paper describes a new core curriculum at North Carolina Central University (NCCU), a state supported black liberal arts college which emphasizes leadership and community service. The new core, "Critical Foundations in the Arts and Sciences" (CFAS), provides more interdisciplinary courses, and facilitates subsequent interdisciplinary study by being brief enough to allow the completion of two majors. The basic goals of the CFAS program are: (1) provide sufficient breadth of knowledge relating to the human experience to facilitate effective functioning in this global information society; (2) provide opportunities for students to develop skills necessary to succeed in academic, professional, and social environments and to facilitate life-long learning; (3) provide the basic skill and knowledge necessary to acquire and process information using traditional and electronic media; and (4) provide specific cultural exposure for NCCU students. The CFAS program delivers the course material more efficiently, so that the total hours required is fewer than that of the traditional core. This facilitates and encourages double majors. Two dual degree programs are described: computer science and mathematics, and computer science and physics. Reading assignments in the math classes motivate students by covering short biographies on the lives of black mathematicians, scientists, and engineers. Achieving accreditation for the computer science degree program is also discussed. (Contains 11 references.) (SWC)

Two Model Dual Degree Programs in Computational Science for Small Universities

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Section 1: Introduction

North Carolina Central University (NCCU), one of the first state-supported liberal arts college for Blacks, is now one of the 16 constituent institutions of the University of North Carolina. Since its founding, NCCU has emphasized leadership and community service; consequently, it is among the top 10 baccalaureate institutions of U.S. Black American Ph.D.'s (Simmons & Thurgood, 1995). In keeping with its leadership role and dedication to community service, NCCU is addressing the difficulty college graduates often face in using their majors to serve the community.

Today, obtaining the solution to a problem often requires using people who are knowledgeable in more than one field (Arney, 1997). People with such knowledge reduce problems that arise from lack of mutual comprehension and lessen communication delays. A few multi-faceted people can solve a problem more efficiently than a larger group of specialists (Johnson & Johnson, 1994). Yet many of today's college graduates have little interdisciplinary experience (Arney, 1997).

Two major factors appear to contribute to the one-dimensionality of most graduates. One is the current trend of requiring more and more courses in the major department, which leads to isolation from related fields. The other is an outdated liberal arts core which has not changed much in the last century (Goodchild & Wechsler, 1947).

NCCU is addressing both of these situations through a new core called Critical Foundations in the Arts and Science (CFAS). CFAS (detailed in Section 2) indoctrinates students to interdisciplinary study through interdisciplinary courses. It also facilitates subsequent interdisciplinary study by being brief enough to allow students to complete two majors. Two dual-degree programs in computational science arise naturally in this setting and provide models for small universities. (Computational science is a methodology for solving problems by using modeling and simulations, data collection, and analysis of large data sets or large calculations.) One is a double

major in computer science and mathematics (detailed in Section 3) and the other is a double major in computer science and physics (also detailed in Section 3).

In the case of computer science and mathematics, interdisciplinary labs (detailed in Section 4) promote the double major by keeping students aware of the relationships between the two programs. Shared resources also make accreditation by the Computer Science Accreditation Board (CSAB) obtainable, and this, in turn, attracts students. Motivation to accept the challenge of the double major (detailed in Section 5) is provided by the lives of Black mathematicians, scientists, and engineers.

Section 2: Indoctrination

The new core was designed by first identifying goals and then designing interdisciplinary courses to accomplish them. The result is believed to provide a better foundation for today's college graduate than does the traditional collection of courses from various disciplines. The interdisciplinary approach of many of the courses not only has the advantage of showing students the interrelationships of many disciplines, but also delivers the material more efficiently, so that the total hours required (41) is fewer than those required for the traditional core (55). The development and implementation of NCCU's new general studies program, CFAS, is one of the primary factors in facilitating and encouraging double majors.

The CFAS program was designed to be a core curriculum for the twenty-first century which would prepare our baccalaureate students to be leaders in a world of cultural diversity, information technology, and interdisciplinary awareness. More precisely, the program has the four basic goals of 1) providing sufficient breadth of knowledge relating to the human experience to facilitate effective functioning in this global information society; 2) providing opportunities for students to develop skills necessary to succeed in academic, professional, and social environments and to facilitate life-long learning; 3) providing the basic skill and knowledge necessary to acquire and process information using traditional and electronic media; and 4) providing specific cultural exposure for NCCU students. CFAS achieves these goals through five academic components consisting of Communication Skills, Proficiency in Mathematics and Science, Cultural Foundations, Arts and Humanities, and Personal and Social Development. This program also is characterized by four underlying themes of writing, critical thinking, global focus, and integrative learning. Additionally, community service through service learning and cultural exposure through lyceum, forum, and campus arts presentations are an integral part of the CFAS program.

The CFAS program is in a large part responsible for giving our students the flexibility to pursue a double major, to minor in one or more areas, or to take a wide variety of electives, complementing and enhancing their professional preparation. The interdisciplinary foundation of CFAS, followed by strong advising linking academic components, ensures that our students become aware of the disciplines and courses that are most suitable for their career opportunities. CFAS is integrated into the entire learning experience and thus affords each student the opportunity to directly contribute to the design of the best career preparation that our university can offer.

The 41 semester hours are distributed over the five units as follows: Communication Skills (15 hours) consists of one year of composition, one year of a foreign language, and one semester of

speech. Proficiency in Mathematics and Science (7 hours) consists of one semester of mathematics with a technology component and one semester of science emphasizing the scientific method. Cultural Foundations (7 hours) consists of one semester of society, behavior, and spatial organization and one semester of world societies. Arts and Humanities (6 hours) consists of one year of the aesthetic, historical, cultural, and social foundations of literature, theater, music, dance, visual arts, philosophy, and religion. Personal and Social Development (6 hours) consists of three courses presenting personal financial management, family systems, career development, physical and mental health issues, ethics and values, leadership roles, disease prevention, health promotion, and CPR training.

Section 3: Sample Double Majors

Double majors are possible for any combination a student desires. None of the special arrangements that have traditionally been required to obtain a double major are needed. Traditionally, to obtain a double major, the departments involved have had cross-listings of courses, agreements about equivalencies of courses, and/or special arrangements regarding electives. With CFAS, there is simply time to complete two majors. So any combination of majors is possible, regardless of whether the departments have special arrangements. Also, any major can be combined with any two minors.

To illustrate the possibilities, Table 1 represents a degree plan for students who are interested in computer science, mathematics, and statistics. The plan includes 25 courses for 77 credit hours. These 77 credit hours combined with the CFAS 41 credit hours leave 6 credit hours of electives to obtain the 124 hours needed to graduate.

Table 1. A double major in computer science and mathematics plus a statistics concentration.

Mathematics plus Statistics	Computer Science	Course Number	Course Name	Semester Hours
x	x	MATH 2010	Calculus I	5
x	x	MATH 2020	Calculus II	5
x	x	MATH 2400	Introduction to Statistics	3
x	x	MATH 3410	Numerical Analysis	3
x	x	MATH 3800	Discrete Mathematics	3
x	x	MATH 4410	Linear Algebra I	3
x	x	COMP 1510	Programming I	3
x	x	PHIL 2300	Logic	3
x	x	PHYS 1310	General Physics for Science I	3
x	x	PHYS 2310	General Physics for Science II	3
x	x	PHYS 2410	Lab I	1
x		MATH 2500	Statistical Methods	3
x		MATH 2030	Calculus III	5
x		MATH 3020	Differential Equations	3
x		MATH 4210	Probability & Statistics I	3
x		MATH 4220	Probability & Statistics II	3
x		MATH 4920	Senior Seminar	3

x	COMP 1520	Programming II	3
x	COMP 2810	Data Structures	3
x	COMP 3300	File Processing	3
x	COMP 3610	Hardware I	3
x	COMP 3710	Computer Graphics	3
x	COMP 4810	Advanced Data Structures	3
x	COMP 4830	Programming Languages	3
x	COMP 4850	Operating Systems	3
x	COMP 4920	Senior Seminar	3

Table 2 represents a degree plan for students who are interested in both computer science and physics. This plan includes 33 courses for 102 credit hours. CFAS adds 41 hours for a total of 143 hours, which can be accomplished by taking 18 hours per semester for four years.

Table 2. A double major in computer science and physics.

Computer Science	Physics	Course Number	Course Description	Semester Hours
x	x	COMP 1510	Programming I	3
x	x	MATH 2010	Calculus I	5
x	x	MATH 2020	Calculus II	5
x	x	PHYS 1310	General Physics for Science I	3
x	x	PHYS 2310	General Physics for Science II	3
x	x	PHYS 2410	Lab I	1
x		MATH 3800	Discrete Mathematics	3
x		MATH 4410	Linear Algebra	3
x		PHIL 2300	Logic	3
x		COMP 1520	Programming II	3
x		COMP 2819	Data Structures	3
x		COMP 3300	File Processing	3
x		COMP 3610	Hardware I	3
x		COMP 3710	Computer Graphics	3
x		COMP 4810	Advance Data Structures	3
x		COMP 4830	Programming Languages	3
x		COMP 4850	Operating Systems	3
x		COMP 4920	Senior Seminar	3
	x	PHYS 2320	General Physics for Science II	3
	x	PHYS 2420	Lab II	1
	x	PHYS 3060	Electricity and Magnetism	3
	x	PHYS 3210	Lab III	2
	x	PHYS 3110	Mechanics	3
	x	PHYS 3220	Lab IV	3
	x	PHYS 3310	Modern Physics	4
	x	PHYS 4110	Statistical Mechanics	3
	x	PHYS 4220	Mathematical Methods	3

x	PHYS 4300	Introduction to Quantum Mechanics	3
x	CHEM 1100	General Chemistry I	5
x	CHEM 1200	General Chemistry II	5
x	MATH 2030	Calculus III	3
x	MATH 3020	Differential Equations	3

Section 4: Promotion of Interdisciplinary Study

Shared labs keep the mathematics and computer science majors very aware of the content of the courses in the two programs, and thus of the relationships between them. Shared labs also make accreditation by the CSAB obtainable, and accreditation makes participation in the program attractive because of almost guaranteed employability.

NCCU is aware of how important it would be for the Computer Science degree program to receive accreditation and is dedicated to achieving this goal. We are currently using as a guide the criteria of the Computer Science Accreditation Commission of the CSAB. We are fortunate that our campus has an extensive campus-wide network consisting of fiber optic connections between each building on campus and our library, which is the hub of our network, and at least one network connector in virtually every room on campus. This, along with grants from the Kenan Foundation, IBM, AT&T, and Title III, has allowed us to build a substantial infrastructure within our department.

One major component of this infrastructure is our AT&T Computer Science Lab consisting of 20 PCS connected to a UNIX server running LanManager 2.01a, using the campus network hardware. This lab is used by computer science, mathematics, and physics majors for programming on an open-shop basis. Adjacent to this lab is our Mathematics Learning Center's multimedia/audio-visual lab, consisting of 10 multimedia PCS connected to our campus network with full Internet access using Netscape and LAN Workplace software. In addition to these two labs, we have a computer classroom, used for teaching computer science classes as well as mathematics classes that are enhanced by using electronic technology. In this facility we have 26 PCS and a Novell-based server which provides connections to our campus network and the Internet for each of these machines. Our faculty also have access to the Internet, as each office, workroom, and classroom has at least one network connection. Each of these computers has a variety of software, including DOS/Windows, C++, Pascal, MASM, FORTRAN, Netscape, MAPLE V, Paradox, QuattroPro, and others. With these facilities, we believe that we can satisfy the criteria of the CSAB in the equipment area.

With the introduction of a new theory of computer science course into our current computer science curriculum (See the current curriculum in Table 1 or 2), we believe that we can satisfy the criteria of the CSAB in the curriculum area as well. The new course has been designed and we have faculty who are prepared to teach it.

This leaves the area of personnel, which is the area in which we must improve the most. At present, we do not have a faculty member with a PhD in computer science. We do, however, have four faculty members, with PhDs in mathematics, who teach most of our computer science courses. Two of these persons have had 10-20 hours of graduate computer science courses at UNC-Chapel

Hill, and the other two have had 30-33 hours of graduate computer science courses at the same university. Also, we have one faculty member who has completed all the course work for a PhD in computer science at Duke University. If we can attract one or two computer science PhDs to complement the faculty we already have, we believe that we will have the faculty needed to satisfy the CSAB criteria in the area of faculty.

Finally, in terms of personnel, we will need to acquire non-teaching personnel to administer our network servers and manage our hardware and software. This is currently done by faculty who also teach four courses per semester. We believe very strongly that , if we can improve our personnel situation, we can qualify for CSAB accreditation in the near future.

Section 5: Motivation: Black Mathematicians

When young people see that someone who looks like them has achieved success and fame, then they begin to have hope that they, too, can achieve similar success or their own personal goals. Consider, for example, the number of young males, especially Black males, who aspire to be like Michael Jordan. Young Black females are now dreaming of becoming another Dominique Dawes. These people achieved fame and have been in the spotlight often enough for young people to want to emulate them.

If these same youth were to learn of Black mathematicians who had achieved fame, then they possibly would aspire to become a great mathematician. Consider the pride a Black student feels when he or she studies a theorem and then discovers that it has been named for a Black person. Or consider this same person using a mathematics textbook as a course text or as a resource, only to discover that it was written by a Black mathematician. When students read about David Blackwell or Albert Bharucha-Reid, they can learn about the obstacles they overcame to become two outstanding statisticians (Smith & Keepler, 1997) and realize that they also can overcome any hurdles they might face to achieve their own goals. Future scientists will be interested to learn about William Lester (Jacobsen, 1995), who is a leading researcher in computational chemistry, or Shirley Malcom, Head of the Directorate for Education and Human Resources Programs of the American Association for the Advancement of Science, who is an expert in ecology (Prestwidge, 1996). The achievements of many other Black scientists and mathematicians serve as inspiration to our students.

To capitalize on the power such role models have to motivate students to succeed, short biographies have been written of several Black mathematicians and are kept on file in the Mathematics Learning Center. Assigned readings in the first two calculus courses, as well as in the history of mathematics course, direct students to these biographies. Appendix C contains the identities and brief descriptions of some of these.

Section 6. Conclusion

Now, more than ever, there is a demand for a group of professionals who are familiar with two or more disciplines. NCCU has found a way to address this need through a compact interdisciplinary core. Mathematics and computer science promote the double major by sharing resources and motivate students to seize the opportunity by providing role models through reading assignments concerning the lives of Black mathematicians, scientists, and engineers.

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Appendix A
Top producers of Black scientists

HBCUs historically have been and still are the prime producers of Black scientific talent in the United States (Simmons & Thurgood). Pearson and Pearson (1985) report that 87 percent of Black scientists received their undergraduate degrees from HBCUs. They also show that HBCUs are the top producers of Blacks who receive their PhDs in science. The following is the ranking of the top 10 producers of Black PhD natural scientists.

Institution	Rank
Howard University	1
Morehouse College	2
Virginia State University	3
Morgan State University	4
Tuskegee University	5
Fisk University	6.5 (tie)
Virginia Union University	6.5
Prairie View A&M University	8.5 (tie)
Tougaloo College	8.5
University of Arkansas (Pine Bluff)	10.5 (tie)
Hampton University	10.5

Appendix B
Top producers of Black PhDs

HBCUs are the leading U.S. baccalaureate institutions of U.S. Black PhDs. The following are the rankings of top institutions from which Blacks who received their PhDs, 1990-1994, received their undergraduate degrees.

Institution	Rank
Howard University	1
Spelman College	2
Hampton University	3
Tuskegee University	4
North Carolina A&T State University	5
Wayne State University	6
Southern University-Baton Rouge	7
North Carolina Central University	8.5 (tie)
Florida A&M University	8.5
South Carolina State University	10.5 (tie)
Jackson State University	10.5

Appendix C
Some legendary Black scientists/engineers

Most people associate the Black man's contributions in science and engineering with the achievements of Benjamin Banneker, who helped design the street layout of Washington, D.C. and wrote the plans for the city, or with George Washington Carver and his important contributions to agriculture and industry, or with Dr. Charles Drew's discoveries in the field of blood plasma preservation. However, these exceptional scientists are only three of literally dozens of Blacks whose genius has contributed to the social and economic welfare of our society through their achievements in science and engineering. In addition to Blackwell and Bharucha-Reid, other mathematicians and scientists have made significant contributions to their fields (Smith & Keepler).

Some of the legendary inventors that our students read and learn about include:

Elijah McCoy--born in Canada of runaway slaves; invented the automatic lubrication for steam engines (fed oil to machinery while it was still running); the reference for "the real McCoy."

Jan Matzeliger--born in Dutch New Guinea; invented the first machine for mass-producing shoes.

Granville T. Woods--earned 35 patents for electro-mechanical devices, bringing about improvements in telegraphy, telephones, automatic cut-offs for electrical circuits, and electric motor regulators; called the "Black Edison."

Lewis H. Latimer--invented inexpensive cotton-thread filament which made electric light practical for homes.

Garrett A. Morgan--invented first automatic stop light; invented a smoke inhalator mask.

Norbert Rillieux--born a slave in New Orleans; invented a vacuum evaporator for turning cane juice into white sugar crystals (his process is still used throughout the sugar industry today).

Lewis Temple--blacksmith; invented movable harpoon head which revolutionized the whaling industry (the Temple Toggle was the most important single invention in whaling history).

Frederic McKinley Jones-invented a removable refrigeration unit that transformed the food transport industry; was awarded more than 60 patents, including portable x-ray machines and sound equipment techniques for motion pictures.

Otis Boykin--invented the control unit in artificial heart stimulators; invented an electrical device used in all guided missiles and in IBM computers.

Meredith Gourdine--was a pioneer in energy conversion; invented many products and processes based on the use of electrogas dynamics technology.

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