

Computer Science Curriculum Redesign at Fort Valley State University

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Abstract

The computer science program at Fort Valley State University (FVSU), a unit of University System of Georgia, is presently undergoing a major revision to reflect the most current trends in the job market and the ABET computer science curriculum requirements. Additionally, the curriculum redesign is needed to increase the program's appeal to students and employers. The underlying principle for this redesign is to provide more flexibility for students to take major and free elective courses and lessen the emphasis on traditional mathematics requirements (such as Calculus II).

Currently, the major area in curriculum of computer science at FVSU includes 60 credit hours of which 9 hours are major electives and 6 hours free electives. The revised program will include 33 credit hours in core curriculum of computer science, 12 credit hours in major electives, and 15 credit hours in free electives. The mathematics requirements will include 17 credit hours with Calculus II placed under restricted electives.

The increased number of credit hours in both restricted and free electives will allow students to obtain academic concentrations or minors in fields of interest. It should be noted that most minor and concentration programs at FVSU require 15-18 credit hours.

It is anticipated that this program revision along with other academic success measures such as building a meaningful student support system would help increase the retention, recruitment, and graduation of students while maintaining a quality undergraduate computer science program aligned with both the University System of Georgia and the ABET requirements. This paper presents curriculum revision and enhancement to the computer science program at FVSU. The details regarding the student support system will be presented in a future article.

Introduction

FVSU is a land-grant institution and one of the Historical Black Colleges and Universities (HBCU) in the state of Georgia. The academic division of the University is organized into three Colleges, namely, Arts and Sciences, Agriculture, Home Economics, and Technology, and Education. FVSU offers more than forty (40) major fields of study and offers degrees in thirty-five (35) undergraduate and seven (7) graduate programs¹.

The Computer Science program is offered in the Department of Mathematics and Computer Science that comes under College of Arts and Sciences. The program was designed and established as undergraduate bachelor degree program in 1981 and the program curriculum devised was heavily based on mathematics and programming contents. For example students had to take upper division level mathematic courses such as Calculus III and Differential Equations under program major requirements. Additionally, students had to take nearly four different programming languages such as Pascal, C, FORTRAN, and Ada at multiple levels. The curriculum went through its first major revision back in 1998 when the university educational

system changed from quarter to semester system. The new curriculum contained fewer mathematics and programming languages courses. It also included courses in modern computing and computer networks. The FVSU computer science program underwent minor changes from 2000-2015 but the main structure of curriculum remained intact.

In 2013, an external audit of the program effectiveness revealed that it was not producing enough graduates to meet the University System of Georgia (USG) minimum requirements of ten (10) graduates annually. As a result, the computer science program was flagged as a low producing program that could potentially be eliminated if this trend was not reversed within a three-year period.

The faculty of computer science program initiated a concerted effort to systematically study this problem from two angles: curriculum enhancement and student support system. With respect to the curriculum enhancement, the program content was carefully reviewed, analyzed, and then compared to those of other institutions. The ensuing study revealed that FVSU computer science program was rigid and did not provide sufficient flexibility to absorb students and graduate them in a timely manner. For instance, the curriculum included only 6 hours of general electives, while similar computer science curriculum in sister institutions within the university system had up to 15 credit hours of free-electives. Additionally, the 24 hours of mathematics courses including only 3 hours of mathematics elective was considered excessive and inflexible as compared with other sister institutions that have 15 to 20 credit hours of mathematics⁴⁻⁶. After analyzing the passing records of computer science students in Calculus II over a three-year period, it was also realized that the Calculus II requirement was a major factor leading to low retention and prolonging graduation duration. Two other sister institutions had a similar situation regarding Calculus II. Further, it was noted that Calculus II was not a prerequisite for any of our existing computer science courses and did not play a critical role in preparing students for their major courses.

This paper presents curriculum revision and enhancement to the computer science program at FVSU. The discussion of student support system will be presented in a future article.

Undergraduate Academic Program

The program of study for any undergraduate program in the USG is divided into two major categories: Core Requirements and Major Requirements. The core area includes 42 credit hours of lower division level courses in several categories (Areas A-E) related to humanities, communications, fine arts, natural sciences, mathematics, technology, social sciences, and institutional options addressing general educational outcomes set by the institution. The major area contains 78 hours of coursework and divided into two subcategories: courses related to the program of study (known as Area F) and courses in major (known as Area G). The Area F courses are lower level division courses required by the degree program and are prerequisites to major courses at higher levels. This Area includes 18 hours of coursework. Area G contains up to 60 credit hours of mostly upper division courses. The USG requires at least 21 credit hours of upper division coursework in the major. And in general, the program of study must have a minimum of 39 credit hours in upper level division courses. The academic balance sheets for

majors that include a “free elective category” need to reflect adjustments made in the number of “major” and “free” electives credit hours with respect to the constraints mentioned above.

Old Computer Science Program (2000 - 2015)

The old curriculum of computer science was structured around 42 credit hours in core requirements, 66 hours in major requirements and 12 hours in free electives. The curriculum underwent a few minor changes in major requirements (Areas F and G) of curriculum from 2000 to 2015. These changes were mainly related to the content of courses including course descriptions and learning outcomes. Also, slight adjustments to the credit hours of few courses in Area G and the establishment of Exit Exam requirement were occurred during the above time period. However, the overall structure of the program remained the same. The following describes the Major Requirements of the curriculum.

The Major Requirements in the Area F of curriculum included 10 hours of introductory computer science programming courses and 8 hours of mathematics: Calculus I and Calculus II. The Area G included 39 hours of upper division courses with 36 in computer science and 3 in mathematics. Out of the 39 hours, 6 and 3 hours were major electives and mathematics electives, respectively. The Area G also contained 9 hours of lower division courses with 3 in computer science and 6 in mathematics.

The curriculum also included 12 credit hours of elective courses--six free electives and six restricted electives (in foreign languages).

Many students graduated under this curriculum were able to obtain high paying jobs within the field of computing or pursue graduate studies in this field right after graduation. The curriculum was also fully aligned with ACM and later with ABET requirements. The major shortcoming of this curriculum was its rigidity that contributed to low graduation especially within the last five years. The program under this curriculum was graduating on average 6 students per year over the last five years. This number was well short of the minimum number of 10 graduates per year set by USG.

The Enhanced Curriculum of Computer Science

A major revision to the curriculum of computer science was initiated in fall 2014 and continued through spring and fall semesters 2015. The curriculum revision was carried out in Major Requirements namely, F and G areas, as well as the free elective area.

As part of the revision process, the curriculum committee of FVSU computer science program carefully reviewed ABET curriculum requirements for computer science and the curriculum of computer science programs in six sister universities within USG. This review was important from two aspects:

- Any major curriculum revision must be aligned with ABET requirements since the FVSU computer science program seeks ABET accreditation in near future

- The revised curriculum should also be compatible with sister universities within USG to facilitate transfer and transit students from these universities to our university and vice versa.

According to ABET accreditation standards a computer science program must have one and one-third years of course work or similar experience in computer science. The coursework should satisfy the following ABET standards²:

- "1. Coverage of the fundamentals of algorithms, data structures, software design, concepts of programming languages and computer organization and architecture. [CS]"*
- "2. An exposure to a variety of programming languages and systems. [CS]"*
- "3. Proficiency in at least one higher-level language. [CS]"*
- "4. Advanced course work that builds on the fundamental course work to provide depth. [CS]"*

The one and one-third years of course work corresponds to 40 credit hours of coursework in colleges and universities within USG.

The ABET science and mathematics standards require at least one year of coursework (equivalent to 30 credit hours) in mathematics and science with the following provisions²:

- "1. Mathematics: At least one half year that must include discrete mathematics. The additional mathematics might consist of courses in areas such as calculus, linear algebra, numerical methods, probability, statistics, number theory, geometry, or symbolic logic. [CS]"*
- "2. Science: A science component that develops an understanding of the scientific method and provides students with an opportunity to experience this mode of inquiry in courses for science or engineering majors that provide some exposure to laboratory work. [CS]"*

In accordance with the above ABET standards, the Major Requirements of the curriculum was revised to increase the credit hours of Principles of Programming II from 3 to 4 and substitute Discrete Mathematics for Calculus II in Area F. This modification to Area F also meets the USG requirement of 18 hours of lower division coursework related to the field of study. In Area G, the curriculum is divided into two subcategories: Required Courses and Restricted Major Elective Courses. The Required Courses section contains 33 credit hours of which 27 hours in upper division computer science courses, 3 hours in a sophomore computer science course, and 3 hours in a sophomore mathematics course. The selection of courses in this section was mainly based on ABET recommendations and best practices by similar institution within USG system. Two new courses that were not required under previous curriculum were added to this section. These courses are: Software Engineering and Web Programming that train students with the knowledge and skills that are valuable to have in the job market and also commonly used by other computer science programs within the USG.

The Restricted Electives section includes 12 credit hours in mathematics and computer science course with this provision that at least 6 hours must be upper level division courses. Calculus II

and Theory of Programming courses that were required under the previous curriculum are now placed under this section. Students now have the option to take courses that are more in-demand in the job market (courses such as Introduction to Information Security and Network and Internet Security) or attractive to graduate programs in hardcore computing.

The free electives courses were increased from 6 to 15 credit hours to provide students with an option to pursue a minor program in other fields particularly in a STEM field. It should be noted that a minor program in USG requires 15-18 credit hours of coursework. Most minor programs at FVSU have 15 credit hours of coursework. The credit hours of free elective courses are consistent with similar institutions within USG.

The course work comparison between the old and new curriculum is shown in the following Table:

Table1: Area G and Free Elective Sections in Revised and Old Computer Science Curriculum

| Revised Curriculum | | Old Curriculum | |
|------------------------------------|---|--|---|
| Course Number | Course Title | Course Number | Course Title |
| Required Courses (33 Hours) | | | |
| CSCI 2201 | Digital Fundamentals (3) | CSCI 2201 | Digital Fundamentals (3) |
| CSCI 3150 | Data Communication and Networks (3) | CSCI 3150 | Data Communication and Networks (3) |
| CSCI 3331 | C/UNIX (3) | CSCI 3331 | C/UNIX (3) |
| CSCI 3351 | Comp Organization/Assembly Language (3) | CSCI 3339 | Theory of Programming Languages (3) |
| CSCI 3410 | Data Structures (3) | CSCI 3351 | Comp Organization/Assembly Language (3) |
| CSIS 3743 | Web Development (3) | CSCI 3410 | Data Structures (3) |
| CSCI 4320 | Software Engineering (3) | CSCI 4000 | Senior Seminar (3) |
| CSCI 4340 | Principles of Operating Systems (3) | CSCI 4109 | Internship (3) |
| CSCI 4520 | Analysis of Algorithms (3) | CSCI 4340 | Principles of Operating Systems (3) |
| CSIS 4720 | Database Systems (3) | CSCI 4520 | Analysis of Algorithms (3) |
| MATH 2113 | Elementary Statistics (3) | CSIS 4720 | Database Systems (3) |
| | Restricted Electives: (12 Hours) At least 6 hours must be 3xxx/4xxx and 6 hours lab science or mathematics courses | MATH 2113 | Elementary Statistics (3) |
| CSCI 2000 | Introduction to Information security(3) | MATH 2253 | Discrete Mathematics (3) |
| CSIS 3100 | Info Technology Hardware & Software (3) | Major Electives (9 hours) | |
| CSCI 3250 | Network and Internet Security (3) | CSCI 3xxx/ 4xxx Level (3) | |
| CSCI 3330 | Contemporary Programming (3) | CSCI 3xxx/ 4xxx Level (3) | |
| CSCI 3339 | Theory of Programming Languages (3) | MATH 3xxx/ 4xxx Level (3) | |
| CSCI 4000 | Senior Seminar (2) | 12 hours of Free Electives (six hours must be in Foreign Languages) | |
| CSCI 4901 | Internship (2-6) | | |
| CSCI 4820 | Artificial Intelligence (3) | | |
| STAT 3000 | Statistical Methods I (3) | | |

| | | | |
|--|--|--|--|
| STAT 3113 | Applied Regression Analysis (3) | | |
| MATH 2164 | Calculus II (4) | | |
| MATH 4363 | Numerical Methods (3) | | |
| NSEN 3400 | Nuclear Science and Engineering I (4) | | |
| NSEN 3500 | Nuclear Science and Engineering II (4) | | |
| Free Electives: (15 Hours) At least 6 hours 3xxx/4xxx Level | | | |
| | | | |

Conclusion

Computer science programs are routinely revised (perhaps more than any other academic programs) to reflect the most current trends in the field and to respond to the growing demand of job market for more trained graduates in the fields of computing and information technology⁷. Major revisions to curriculum of a program should be considered from two vantage points: program integrity and student welfare. Professional accreditation organizations within the field provide curriculum standards and suggestions that are vital to the rigor of program. These standards should be followed to ensure program integrity remains intact. The curriculum flexibility offered by these organizations should be tailored to the demands of job market, the best interest of students, and also the academic institution. Understandably, the timely graduation of students is very important to both students and the institution. Often, many institutions measure the success of a program based on the number of graduates it produces versus the number of students entering the program. If these two numbers are not reasonably balanced, the program could be considered as a low producing program and subjected to elimination or absorption by other related fields as a special track or minor program.

The program of computer science at FVSU has gone through a major revision to increase its viability and enhance its appeal to students. These modifications have been carried out in accordance with ABET standards and USG requirements for an undergraduate degree program in computer science. The revised curriculum provides more flexibility and opportunities for students to pursue minor programs in fields of their interest.

Students who fall under previous curriculum and would be affected by new changes will not be required to follow the new curriculum. Our initial review of coursework of junior and senior students shows that only a handful of students would be affected by these changes. Every effort will be made to ensure that the graduation of affected students will not be prolonged and/or they are required to take additional courses because of these changes.

It is anticipated that the changes to the curriculum along with new measures for student success in the major will reverse the low graduation rate, improve retention rate, and increase recruitment of new students to the program. The new changes also will pave the way to create concentrations/tracks within computer science major in near future. In fact, Cyber-security and Mobile Programming curricula are currently under development and expected to be completed by fall 2016 when the university funds to hire new faculty for these areas would be made available.

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