A Curriculum Coordination Project for Computer Science Transfer

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Key words: Articulation, Transfer courses, Computer science courses

Abstract

The curriculum articulation between 2-year to 4-year institutions plays an important role in postsecondary education pipeline. An NSF funded program at Salisbury University sponsored a year-long curriculum coordination project in computer science with two of its regional feeder community colleges. Progress has been made in aligning the existing curriculum of the three institutions with national standards; increasing the number of transferrable courses; and mending the current course content to ensure the success of transfer students. Issues in the current transfer process have also been identified and both temporarily solutions and more permanent remedies are proposed. The effort by this curriculum coordination project is an important first step in the meaningful communication and collaboration among computer science faculty at the three institutions and it marks the beginning of an on-going effort to enable a seamless transfer process.

1. INTRODUCTION

As the number of 2-year college to 4-year college transfer students continues to grow, paying attention to the 2-year to 4-year college transfer is of extremely importance. However, according to Cuseo (2007), there is a significant gap between the number of students who enter 2-year colleges with the intention of transferring to 4-year institutions and the number who actually do transfer. For students who do transfer, they are likely to encounter significant post-transfer adjustment difficulties during their first term of enrollment at 4-year institutions. Many man-made barriers in policies and procedures interfere with a seamless transfer from 2-year to 4-year institutions. From the aspect of curricula, many confusion and difficulty exist regarding the transferability of courses from 2-year to 4-year colleges. Sometimes, 4-year institutions may refuse to accept transfer courses due to curricular rigidity; or accept those courses as elective credits instead of credits toward general education or an academic major. Curricular changes in 4-year institutions are usually made without consideration of their implications for potential transfer students.

Currently transfer programs rely on formal cross-institutional articulation agreements. Two latest computer science curricular standards by the ACM and the IEEE Computer Society: “Computer Science 2008” for 4-year programs and “Computing Curricula 2009: Guidelines for Associate-Degree Programs in Computer Science”, establish transfer equivalencies between 2-year and 4-year programs to foster articulation in computing science education. The standards emphasize “effective and efficient articulation” among sending and receiving institutions and assign the responsibility for successful articulation to both students and faculty. An efficient and effective articulation requires accurate assessment of courses and curriculum content as well as meaningful communication and cooperation. When a 2-year college develops...
transition and articulation strategies for the institutions to which its students most often transfer, it should be flexible to modify course content to facilitate transfer credit and articulation agreements. The standards also recognize the importance of the receiving institution’s faculty providing transitional preparation for transfer students. The reports remind faculty at receiving institutions to be sensitive to the needs and issues of transfer students.

In the summer of 2010, Salisbury University (hereafter SU) was awarded a 5-year NSF STEM Talent Enhancement Program grant to develop Bridges for Salisbury University’s Connections to Careers for Every STEM Student (SUCCESS) program. Students who initially enter college with the intention of majoring in science, technology, engineering, or mathematics (STEM) fields have substantially lower completion rates in these disciplines than do their peers who enter with aspirations for a non-STEM major (Huang et al. 2000). The Bridges for SUCCESS program is designed to increase the number of graduates in selected STEM disciplines by 75% within five years through expanded outreach, recruitment, enrichment, and retention activities. Using this grant, SU is working to create bridges for success by mentoring students from high schools and community colleges through baccalaureate degrees and then on to careers in a STEM field.

One of the five activities designed to create these bridges is to facilitate the seamless transition of community college students to SU STEM majors through academic and transition support. For academic support, SU established three curriculum coordination teams for computer science, physics, and earth science. Each team composed of faculty from SU and two of its regional “feeder” community colleges, Chesapeake College (CC) and Wor-Wic Community College (WWCC). The purpose of this curriculum coordination is to develop processes for evolving disciplinary standards, to improve student learning at both 2- and 4-year institutions and to improve the success of students transferring from the two community colleges to SU. The curriculum coordination teams selected the introductory courses within each discipline and worked to better align the curricula for those introductory and supporting courses. They also reviewed the discipline standards for each discipline and assessed the gap between their existing curricula. Issues that hinder the seamless transition process were identified and recommendations to work on those issues were proposed to their respective departments for consideration.

This paper reports the curriculum coordination activities for computer science (CS) program. The rest of the paper is organized as the following: Section 2 reports the activities conducted during the CS curriculum coordination. Section 3 discusses the CS transfer issues between WWCC, CC and SU and proposes recommendations to resolve those issues. Section 4 gives a brief summary of this year-long project.

2. CURRICULUM COORDINATION ACTIVITIES

As one of the selected STEM disciplines in SU Bridges for SUCCESS program, the CS curriculum coordination team was constructed by two faculty members from SU, CC and WWCC respectively. The team met seven times between August 2010 and June 2011. Between those meetings, the team actively communicated via emails. Several activities were conducted to: i) better align the curricula for introductory and supporting CS courses among SU, WWCC and CC; ii) map those introductory courses with the national standards; iii) enhance effective transfer of CC and WWCC courses through interaction and communication among faculty members; and iv) propose recommendations for issues in CS transfer process.

2.1 Alignment with National Standards

The CS team reviewed the latest national CS curricular standards: “Computer Science 2008 for 4-year programs” and “Computing Curricula 2009: Guidelines for Associate-Degree Programs in Computer Science”. The “Computing Curricula 2009” strongly recommends that the entire CS I, CS II and CS III core course sequence and a minimum of two mathematics course: Discrete Structures and Calculus I, should be completed at 2-year institutions. The document also outlines the student learning outcomes (SLOs) for CS I, CS II and CS III.

After reviewing the SLOs for those three courses, the team created a mapping of the SLOs and their equivalents at SU, WWCC, and CC. The mapping results for CS I show that both SU and CC have either met or surpassed all eight SLOs and WWCC needs to meet or surpass four more SLOs. Both SU and CC have either met or surpassed all eight SLOs of CS II and WWCC needs to meet or surpass two more SLOs. For CS III both SU and CC have either met or surpassed seven out of the eight SLOs except the topic on information security. WWCC does not offer courses equivalent to CS III.

Two math courses, Discrete Structures and Calculus I, are recommended by the two standard reports for transfer CS programs. Both SU and CC offer those two courses. WWCC offers Calculus I but
does not offer discrete mathematics. Since this curriculum coordination focuses on the CS courses only, mapping between the national standards for those two courses and SU, CC and WWCC was not conducted. However issues for current transfer and recommendations for better transfer of those two courses were given later in the paper.

The “Computing Curricula 2009” report also recommends the inclusion of additional intermediate computing courses to be transferred. However, whether each individual course will be transferred or not is determined by each institution based upon the resources of the 2-year institution and the size of the CS transfer program. In summary, out of the thirteen recommended courses, SU offers nine, CC offers eight, and WWCC offers four. The detailed result of this mapping is summarized in Table 1 in Appendix.

Both reports include many security topics in computing programs. However, the security topics are not presented in lower level CS curricula for all three institutions involved.

2.2 Review Existing and Identify New Transfer Courses

Another activity performed by the CS curriculum coordination team is to review the current CS course curricula of CC and WWCC to discover the content discrepancy of the existing transfer courses and identify new transfer courses.

WWCC’s Transfer Program

Before the curriculum coordination project, there were two existing transfer courses from WWCC to SU: CS I and Calculus I. CS I has been accepted as a transfer course for many years. However, beginning fall 2010, SU added several advanced topics such as classes, objects, constructors and copy constructors, assignment operator overloading, destructors, operator overloading, pointers, and dynamic memory allocation to CS I. Although the transfer agreement for this course is not affected by those changes, to help transfer students succeed in CS II at SU, the inclusion of the above mentioned advanced topics to WWCC’s CS I is highly recommended. Calculus I is another course transferrable to SU. However, the previous experience has shown that WWCC’s transfer students have difficulty completing the successor course, Calculus II, at SU. Since the review and discussion on math courses is out of the scope of this curriculum coordination project, only recommendation on this issue is given in the end of the paper.

During the curriculum coordination project, two additional computer science courses from WWCC have been identified as transferrable to SU: Programming Fundamentals and Microcomputer Organization. WWCC faculty and SU faculty who teach those two courses met and determined that those two course content from WWCC satisfies the corresponding course requirements for SU’s courses respectively.

CC’s Transfer Program

There were six CS courses from CC transferrable to SU before this project: Microcomputer Organization, CS I, Discrete Structure, Calculus I, Calculus II and Statistics. These transfers have been in place for many years. Since the CS faculty at CC and SU maintain regular contact in the past, changes made to SU’s courses have always been incorporated in CC’s curriculum promptly.

One point worth noting is that, although CC’s Statistics course has always transferrable, when SU added a lab component to its Statistics course, transfer students were required to take the 1-credit lab course to meet SU’s full requirement for this course. Recently, recognizing the problem caused for transfer students, SU has eliminated the lab requirement for transfer students.

An agreement was signed between CC and SU to allow two additional CC courses to be transferred to SU. During one of the curriculum team meetings, CC faculty and SU faculty who teach Programming Fundamentals and CS II met and determined that those two course content from WWCC satisfies the corresponding course requirements for SU’s courses respectively.

2.3 Course Transfer Agreement

ArtSys is the articulation system used by Maryland colleges and universities for transfer courses. In the past, ArtSys has recognized transfers of several individual CS courses from CC and WWCC to SU. However, there is always a delay in updating ArtSys with the new transfer courses due to administrative delay and rigidity. To be able work around those man-made barriers, the CS curriculum coordination team recommended the use of memo of understanding signed by relevant parties to deal with case-by-case transfer and newly identified transfers. During the year-long curriculum coordination activities, the team developed two memos of understanding. The first letter of understanding is between CC and SU. Since the CS program at CC has been terminated effective May 2011, the memo serves to facilitate the smooth transfer of two CC students to SU’s CS program within the next year. This memo was signed between CC and SU to give
them the credits for several courses taken at CC. Another memo of understanding was signed by WWCC and SU. It lists all existing and newly identified WWCC’s CS courses transferrable to SU. This memo can be used to help incoming transfer CS students from WWCC temporarily before ArtSys gets updated with the new transfer courses.

2.4 Road Map for CS Transfer from WWCC or CC to SU

Another deliverable produced by the CS curriculum coordination team is a road map (see Figure 1) for CS transfer students from WWCC or CC to SU. In this road map, all courses transferred to SU have been incorporated to the chart. By examining this chart, any transfer CS students can see clearly where they are in the CS program at SU. The road map will be available on WWCC and CC campus so that they can be available easily to interested students. Again, in order to ensure a seamless transition, a student who is enrolled in a CS transfer program is responsible for meeting with his/her transfer advisor each semester and check SU’s requirements periodically. However, it is also expected that if SU’s CS program requirements and/or its CS course content change, the WWCC and CC will be notified in a timely manner.

3. ISSUES AND RECOMMENDATIONS

During the curriculum coordination process, the team has identified several existing issues that hinder the success of transfer students from CC or WWCC to SU. Those issues are summarized as followings:

1. Courses that transfer but do not fully prepare students for subsequent courses at SU. Experience has shown that many of WWCC’s transfer students do not have sufficient amount of knowledge or skills to do well in subsequent courses at SU. There are many factors contribute to this. One factor is that insufficient amount of content is taught at WWCC. Another factor is that the changes made to those transferrable courses at SU also raise the expectation of transfer students.

2. Courses in SU’s year 1 and year 2 curricula that are not required by the sending institutions’ CS programs. For example, WWCC does not offer Discrete Mathematics, Calculus II, or CS II because their CS program does not require those courses. Thus WWCC’s CS transfer students must take those courses at SU and hence will encounter some delay in their graduation.

3. Different and/or new programming environments and operating systems are used at the receiving institution. For example, at SU, CS students are required to use Linux for CS II and many upper-level CS courses. However, some WWCC and CC students may not have experience with a UNIX/Linux program development environment before transferring to SU. This is very frustrating for transfer students and often causes a lot of anxiety when students transfer to SU.

4. ArtSys is not always updated in a timely manner. Difficulties in keeping ArtSys updated make it harder for prospective students to determine if a course or program is, in fact, transferrable. Although everyone agree that it is important that when changes that affect transferability are made to a program or course, the changes should be reflected in ArtSys, no one seems to know who and how to get ArtSys to recognize a course or program as officially transferrable.

To help address those above identified issues, the curriculum coordination team provides the following recommendations:

1. The dialog among the CS faculty at the sending and receiving institutions established by this team should continue. Collaboration among the mathematics faculty at the three institutions must also be encouraged. Transfer course content and
student success in subsequent courses at the receiving institution must be monitored.

2. To strengthen the chance for success of WWCC’s CS transfer students, WWCC needs to:
   i) meet or surpass several SLOs specified in the national standards for the CS I and CS II courses
   ii) keep its CS II course content consisted with SU by including the advanced topics discussed earlier.

3. Several courses (Discrete Mathematics, Calculus II, CS II) in SU’s year 1 and year 2 curricula are not required by the WWCC computer science programs. The team recommends that WWCC consider adding these courses when its resources allow this.

4. An effort must be made to accommodate students who are new to Linux at SU. The team recommends that SU provides a few self-paced or assisted lab sessions on the basics of using Linux for editing, compiling, linking, and debugging programs to students with no prior Linux programming experience.

5. The administrative issues in updating ArtSys need to be clarified. If guidelines on how to update ArtSys exist, they must be published and easily accessible by all relevant institutions. The contact person responsible for completing the process must be known to faculty at both the sending and receiving institutions.

6. Both the national standards for CS programs stress the incorporation of information security topics to computing programs. However, none of the three institutions involved have security topics in their lower level CS curricula. This situation needs to be changed as soon as possible in order to keep their CS curricula up to date.

4. SUMMARY

The main focus of this CS curriculum coordination team was to ensure a more seamless transfer for CS students from WWCC and CC to SU by reviewing the national standards and the current CS curriculum content, reviewing existing and new transfer courses, identifying the issues of the current transfer process, and providing recommendations.

When two national CS standards were reviewed, the SLOs for the three CS course sequences defined in the standards were examined, and a determination was made on where each of the three institutions stands for each SLO.

When this project began in fall 2010, only a handful of CS courses from WWCC and CC transferred to SU. Also before the project started, there was no communication between CS faculty at WWCC and SU. Due to the efforts of this curriculum coordination team, the number of transferrable CS courses has been increased significantly. This collaboration has also led to a better understanding of the CS curricula of the three institutions.

Course articulation is now well-defined via memos of understanding. These memos will assist the transfer of CS students when ArtSys does not reflect the most updated course articulation agreements. A “Road Map” was created so that transfer students can use it to see at a glance the SU course to which their associate level courses transfer, and their standing in SU’s program.

Although 100% articulation is not possible at this time, the collaboration among faculty at three institutions during this curriculum coordination project marks the beginning of on-going effort to enable students to transfer in as seamless a manner as possible. Faculty members at the receiving institution are more sensitive to the needs of incoming CS transfer students, and steps are being taken to ensure that those needs are met. Those meaningful communication and cooperation and ongoing assessments of courses are essential for transfer students’ success, and the effort by this curriculum coordination team has been an important first step.

5. ACKNOWLEDGMENTS

The author would like to thank Don Nicholson, Mary Lou Malone, and Sang-Eon Park and other faculty members from SU, CC and WWCC for working together on this project. This project is supported by SU Bridge for SUCCESS undergraduate research grant funded by the NSF.

6. REFERENCES

## Appendix

### Table 1. Additional (optional) Courses for 2-year Transfer Program Mapping

<table>
<thead>
<tr>
<th>Courses Recommended</th>
<th>WWCC</th>
<th>CC</th>
<th>SU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algorithm Analysis &amp; Design</td>
<td>None</td>
<td>CSC 220</td>
<td>COSC 220, 320</td>
</tr>
<tr>
<td>Computer Organization &amp; Architecture</td>
<td>EET 200 Microprocessors</td>
<td>CSC 250 Microcomputer Organization</td>
<td>COSC 250 Microcomputer Organization</td>
</tr>
<tr>
<td>Human-Computer Interaction</td>
<td>None</td>
<td>None</td>
<td>COSC 425 &amp; 426, Software Engineering I and II</td>
</tr>
<tr>
<td>Essentials of Computer Security</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Intro. to Database Systems</td>
<td>CMP 255 Database Design &amp; Management</td>
<td>Course exists but not required in CS program.</td>
<td>COSC 386 Database Implementation</td>
</tr>
<tr>
<td>Intro. to Software Engineering</td>
<td>None</td>
<td>Concepts introduced throughout programming courses.</td>
<td>COSC 425 &amp; 426, Software Engineering I &amp; II</td>
</tr>
<tr>
<td>Linux Operating System</td>
<td>Course that introduced Linux exists.</td>
<td>Course on Linux exists.</td>
<td>COSC 350 System Programming, 450 Operating Systems. Use Linux in many CS courses.</td>
</tr>
<tr>
<td>Programming Languages</td>
<td>None</td>
<td>None</td>
<td>COSC 422 Organization of Programming Languages</td>
</tr>
<tr>
<td>Survey of Computing Disciplines</td>
<td>None</td>
<td>CIS 109 Introduction to Computers.</td>
<td>None</td>
</tr>
<tr>
<td>XML-Enabled Technologies</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Digital Logic Circuits with Lab</td>
<td>None</td>
<td>CSC 250 Microcomputer Organization</td>
<td>COSC 250 Microcomputer Organization</td>
</tr>
<tr>
<td>Circuit Analysis with Lab</td>
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<td>None</td>
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