



WHITE PAPERS

Transfer Pathways in Cybersecurity Education: Challenging Routes, Promising Practices, Possible Improvements

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Context: The Challenging World of College Transfer Credit

In American higher education, the term transfer pathways refers most commonly to the process of enabling community college students to prepare themselves to transfer to a four-year college or university and earn a baccalaureate degree (e.g., Handel and Williams, 2012). In reality, college transfer pathways are more numerous and varied than that. Other types of transfer pathways include lateral transfer, i.e., transfer to the same type of institution (two-year or four-year) as the one in which a student is currently or previously enrolled, and reverse transfer, i.e., transfer from a four-year to a two-year institution (Council for the Advancement of Standards in Higher Education, 2011; Poisel & Marling, 2011). There are also several types of transfer pathways for making the transition between two-year and four-year institutions.

One of the common characteristics shared by these various types of transfer pathways, unfortunately, is that they are challenging and often quite difficult to negotiate, especially from the student perspective. The transfer process has been described as an “academic gauntlet” consisting of several central challenges that community college students must overcome to transfer successfully to a four-year institution, including “insufficient information about the transfer process; nonexistent or indecipherable policies specifying how their community college credits will transfer; and enormous complexity in satisfying requirements for possible admission to multiple four-year institutions” (Handel 2013). From the institutional perspective, a recent commission identified five challenges which hamper the effective implementation of the transfer pathway from community college to baccalaureate programs: lack of knowledge about the actual capacity of this transfer pathway to accommodate more students; lack of institutional incentives supporting this transfer process; loss of most potential transfers due to numerous breaks in the transfer pipeline; lack of continuous financial aid support for transfer students; and differences and conflicts between the academic cultures of two- and four-year institutions which hamper transfer student progress (Handel and Williams, 2012). This commission also found that transfer remains a popular route to the baccalaureate degree and that more students wish to transfer, but the transfer rate has not improved, in part because the transfer process is too complex. The commission’s findings also stated that the effectiveness of statewide articulation policies in boosting transfer has not yet been established empirically, but transparent transfer credit policies remain essential for student success. As these sources indicate, the existing transfer pathway process is a challenging, complex, and at times even byzantine system.

The challenges faced by students seeking to transfer from one institution to another also apply to transfer pathways for degrees in cybersecurity and related programs. This paper identifies several varieties of transfer pathways and describes the current state of practice as they relate to cybersecurity degree programs. This paper also identifies some promising or potentially exemplary practices related to transfer pathways, both in general and related to cybersecurity education in particular, and concludes with a proposal for improving the transfer pathway system for cybersecurity education students.

Varieties of Transfer Pathways

Articulation Agreements: The Standard Route

Articulation agreements are arrangements between institutions (typically between a two-year and a four-year school) which specify how a student completing courses at a community college can satisfy requirements for completing a bachelor's degree at a four-year college or university, including course, general education plan, major, or other related requirements. Articulation agreements have been the policy instrument of choice for linking the curricula of two- and four-year institutions. Although the definition of an articulation agreement sounds simple enough, they are complex in practice and rarely written with the student in mind, as Stephen Handel notes in his 2013 report *Transfer as Academic Gauntlet: The Student Perspective*:

The nearly endless number of interinstitutional articulation arrangements necessary to link curricula at two- and four-year institutions has led to the creation of an articulation bureaucracy, stunning in its complexity and nuance, which often hampers rather than assists students' academic progress. Students' need for information about course transferability competes against interinstitutional faculty infighting over control of the undergraduate curriculum, concerns over community college course rigor, the intellectual provincialism of the four-year institution, and a host of other issues. This can lead to articulation agreements that are less clear than they could be in describing how credits transfer from one institution to another.

Handel also describes how students tend to experience articulation agreements as a complex code which students must decipher in order to have any chance of using an articulation (Handel 2013). The complexity of articulation agreements, especially from the student perspective, underscores the need for most students to have help from institutional support services such as advisors, and counselors to negotiate the transfer process successfully. Unfortunately, such resources are decreasing in supply; as one recent report indicated, community college budget cuts have hit student services especially hard, and counselor-to-student ratios are usually quite high, commonly ranging between 1:800 and 1:1,200 (Scott-Clayton, 2011, p. 7).

Articulation Agreements in Cybersecurity Education

There are numerous existing articulation agreements in cybersecurity. The National CyberWatch Center reported almost 40 articulation agreements involving its members as of December 2012, and the CyberWatch West NSF ATE regional center reports at least 14 articulation agreements among its members. Members of other NSF ATE regional cybersecurity centers have also created articulation agreements, and some single institutions such as the University of Maryland University College and American Public University System have articulation agreements with numerous institutions for their cybersecurity-related programs.

The actual number of articulation agreements related to cybersecurity-related programs is unknown but likely numbers in the hundreds, and they offer numerous individual transfer pathways for students. Nevertheless, this existing array of articulation agreements leaves much to be desired, as it suffers to a large extent from the same factors which comprise the broader critique of articulation agreements. The existing system of articulation agreements in cybersecurity education is a patchwork which lacks the transparency that is essential for student success.

Statewide Transfer Pathway Models: The Bulk Route

To address the patchwork nature of existing interinstitutional articulation agreements, there are various efforts to improve student transfer policies at the state level. Some of these more basic efforts include the following (Bautsch, 2013):

Common course numbering systems aim to ease credit transfers between public two- and four-year colleges within a state by applying the same titles, identification numbers and descriptions to comparable courses. Most commonly, common course numbering applies only to lower-division courses, and the goal of the policy is to eliminate confusion about transferability of lower-division coursework. About 30 states currently either have enacted common course numbering systems or have laws creating them.

General education core curriculum is another strategy for enabling lower-division courses to transfer from one college to another. As their name implies, such courses are meant to fulfill general education requirements, and thus are meant to be transferred more easily from one college to fulfill that purpose. A total of 40 states have either implemented a transferable general education core curriculum or have authorized it.

State-wide transfer pathways are a system of course schedules, advising tools, and interinstitutional agreements designed to help students transfer from a two-year to a four-year institution. A prominent example of this is the Tennessee Transfer Pathway (TTP) program, which is designed to help community college students plan for transferring to a four-year school in Tennessee. Students at Tennessee's 13 community colleges can choose from 40 majors and find pathways to 29 four-year institutions; notably, TTPs also include non-profit and private colleges and universities (Tennessee Board of Regents, 2015).

State-wide articulation agreement systems are designed to facilitate "2 plus 2" policies that assist with the transfer from a two-year school to a four-year school. For example, Florida's Statewide Articulation Agreement guarantees that students who earn an associate of arts degree from a Florida college can transfer those credits to a state university and count all 60 credits toward a bachelor's degree (Bautsch, 2013). California's Project ASSIST (Articulation System Stimulating Interinstitutional Student Transfer) is a statewide repository of the state's articulation and transfer information for its public higher education institutions; its mission is to facilitate the transfer of students from California Community Colleges to California's public four-year

universities through an electronic academic planning system that offers “accurate, timely, and complete information” (ASSIST, 2015).

Some statewide efforts utilize multiple pathways for creating transfer credit programs. For instance, the Maryland Intersegmental Chief Academic Officers (MICA0) identified several existing pathways or initiatives in place at Maryland higher education institutions, including:

- Pathways contained within well-established existing associate degree transfer programs such as computer science and engineering;
- Pathways from well-established two-year applied (AAS) associate degree programs which also served as transfer programs;
- Programs explicitly identified as cyber security programs; and
- Initiatives aimed to infuse cyber security outcomes throughout an entire institution.

The intent of recognizing these multiple approaches is to enable individual four-year schools to focus on the pathway(s) that best fit the institution’s mission and resources (University System of Maryland, 2011).

Although policies at the statewide level are important elements in the larger transfer pathways picture, they also suffer from various problems. All statewide systems are limited to institutions within that state. Common core numbering systems and general education core curriculum requirements have a relatively modest impact and are usually limited to public institutions. Statewide articulation agreement systems remain an often undecipherable code for students; for instance, California’s Project ASSIST has been described as “the first, and...perhaps the best, program for systematizing and presenting articulation information”; nevertheless, such systems illustrate how complicated it is for a transfer student to try to use them (Handel 2013).

The effect of statewide transfer pathway policies on cybersecurity education is also relatively limited at present. Many state transfer pathway programs, for instance Tennessee’s TTP program, do not appear to include any cybersecurity-related programs. A newly developed program to create a smoother transfer pathway between cybersecurity education programs at California community colleges and some California State Universities could have a wider statewide application; however, various institutional obstacles may limit the wider application of that initiative. Some statewide transfer pathway programs (or the institutions participating in such programs) also limit the teaching of cybersecurity-related courses to the four-year schools, thus impeding the development of cybersecurity degree and certificate programs at the two-year level.

Each of these approaches represents an attempt to facilitate transfer through statewide policies and practices that apply to students “in bulk.” Although they remain problematic, they are worth exploring to improve their potential to create more effective transfer pathways for cybersecurity education.

Applied Baccalaureate Degree Programs: The Direct Route

An applied baccalaureate degree has been defined as a bachelor's degree which incorporates applied associate courses and degrees once considered as 'terminal' or non-baccalaureate level while providing students with marketable job skills such as higher-order thinking skills and advanced technical knowledge (Townsend, Bragg, & Ruud, 2009). Although the creators of this definition noted that it does not adequately describe the variation and complexity of applied baccalaureate degree programs in practice (Rudd and Bragg, 2011), it captures the basic meaning of the term. Applied baccalaureate degrees are offered by both two-year and four-year institutions, but those offered by community colleges, commonly referred to as community college baccalaureate (CCB) degrees, are an important subset of applied baccalaureate degrees for several reasons, most notably because they offer a more direct degree pathway that does not require transfer between institutions.

CCB degrees are presently offered in 21 states (Community College Baccalaureate Association, 2016), almost double the number which offered them just five years ago (Rudd and Bragg, 2011). Their reach is limited in some states; for example, Michigan's 28 community colleges were authorized in early 2013 to offer bachelor's degrees in four specialty areas: maritime technology, energy production, culinary and cement technology (NMC, 2013). In terms of applied baccalaureate programs in cybersecurity and related areas, the state of Washington appears to be the leader, with three relevant BAS degree programs in place and two more under development (SBCTC 2015):

- Bachelor of Applied Science in Cybersecurity and Forensics, Highline Community College
- Bachelor of Applied Science in Cyber Security, Columbia Basin College
- Bachelor of Applied Science in Information Technology: Network Administration and Security, Green River Community College
- Bachelor of Applied Science in Information Technology-Networking-System Administration, Yakima Valley Community College (2016)
- Bachelor of Applied Science in Information Technology: Networking, Whatcom Community College (2017)

Florida also has applied two baccalaureate programs in cybersecurity or related fields (Community College Baccalaureate Association, 2016): Indian River State College has an applied baccalaureate degree program in Information Technology Management and Cyber Security (IRSC 2016), and Palm Beach State College has an applied baccalaureate degree program in Information Management with a Security and Network Assurance concentration (PBSC 2016). Two other Florida community colleges, Florida State College in Jacksonville and Eastern Florida State College, have an applied baccalaureate program that includes one or more information security-related courses (FSCJ, 2015; EFSC, 2016).

Although CCBs are controversial even in states that already allow them (Marcus, 2014), they are seen as filling an important need. Continued progress with cybersecurity-related CCBs in Washington and Florida is notable, and it will be worth watching to see if this trend spreads to other states which allow CCBs.

Another variety of transfer pathway is exemplified by Oklahoma State University Institute of Technology, which offers both Associate degrees and a Bachelor of Technology (BT) in Information Technologies. The AAS and AS degrees include courses related to information security, while the BT degree offers an Information Assurance and Forensics specialization option (OSUIT, 2015).

Dual Admission: The Cooperative Route

Dual admission, sometimes also called co-admission, refers to programs for simultaneous enrollment in a two-year college and a four-year college or university. The term causes some confusion because it is also sometimes used (along with the term dual enrollment) to refer to programs which allow high school students to take college courses. Although the focus of this paper is on transfer pathways within higher education, dual enrollment and other high school-to-college pathways can influence cybersecurity programs in higher education. For instance, some community college cybersecurity certificate programs are designed to integrate seamlessly with vendor-specific certification preparation programs or other high school curricular offerings.

Although there are plenty of dual admission programs in US higher education, a preliminary search for dual admission cybersecurity programs has yielded no clear results. Portland (OR) Community College's Computer Information Systems program includes Network Security and Computer Forensics as a topic, and PCC's CIS degree transfers to Southern Oregon University and the University of Oregon, but it appears that no cybersecurity-related degree or certificate is involved (Portland CC, 2015).

Dual admission programs may be a productive avenue for cybersecurity education to pursue. For instance, evidence indicates that the co-admission program between Portland Community College and Portland State University in Oregon has been a successful strategy in easing transfer. However, the success of such programs is dependent upon having dedicated transfer staff available to provide multiple forms of support before, during, and after the transfer process to co-admitted students (Handel and Williams, 2012).

In some cases, there may be pathways which especially savvy students could use or which could easily be made more accessible and transparent to students. For instance, Montgomery County Community College (PA) will be offering an AAS Computer Networking degree with a Cyber Security specialization starting in fall 2015; MCCC also has a dual enrollment program with Wilmington University (DE), which raises the possibility that a student could combine these two programs to create an effective dual enrollment transfer pathway.

Informal Transfer Pathways: The Relationship-Based Route

In practice, faculty at some institutions apply a more informal approach to enabling their students to transfer from one institution to another. In essence, this type of transfer pathway depends on the collegial relationships between faculty at two-year and four-year institutions. For instance, a faculty member at Community College A may identify one or more students whose academic performance and/or other demonstrated qualities indicate that they would be a good match for a program at University B. The faculty member talks to his or her colleague at the university to recommend the student. If the university faculty member is agreeable, then the community college faculty member informs the student and helps facilitate the process as needed. This type of transfer depends in part on the student being able to meet the university's admission requirements, but it does not necessarily use an existing articulation agreement between the two institutions; in fact, it may bypass the existing articulation agreement entirely, or no articulation agreement may be in place. This appears to happen in part as a reaction to the difficulties with navigating the existing transfer process and with using existing transfer pathways such as articulation agreements.

Northern Virginia Community College (NOVA) successfully leverages this method, in addition to standard articulation agreements, to facilitate transfer opportunities to more than five senior institutions for their Cybersecurity AAS degree. This includes a transfer of the program, in full, to George Mason University's Bachelor of Applied Science – Cybersecurity degree that is located in their Adult Learning department. NOVA students are provided an Advising Sheet that details the minute program changes senior institution partners expect to see in transfer students. While NOVA's Cybersecurity AAS degree includes both informal transfer paths, as well as the more formalized articulation agreements, there is not a discernible difference in the outcome between the two (Leary, 2015).

Lateral Transfer: The Direct Route

As noted previously, lateral transfer refers to transfers to the same type of institution (two-year or four-year) as the one in which a student is currently or previously enrolled. Lateral transfers can be problematic for students for the same reasons that interinstitutional transfers can be problematic: insufficient information about the transfer process, non-acceptance of course or program-applicable credits from one institution to another, lack of institutional incentives supporting the transfer process, financial aid issues, etc.

In cybersecurity education, enabling structures such as the National CyberWatch Center's model curricula are intended to support the growth of cybersecurity education by offering updated curriculum models which are modular, mapped to federal and national standards, and aligned with industry job roles, among other features. National CyberWatch Center has also shared stackable credential models in support of this process (National CyberWatch Center, 2015). Although not explicitly stated on its web site at present, the NCC model curriculum could

also serve as a vehicle to aid with the lateral transfer process by providing a set of common courses that could be accepted for transfer among institutions which have those course offerings.

However, in practice institutions tend to develop their own particular program requirements. Even institutions which used the NCC model curriculum when it was first developed in the mid 2000s usually adapted it to their particular program structure rather than adopting it completely. In addition, there is little readily available evidence to indicate how successfully students who transfer from one cybersecurity degree or certificate program at the two-year level are able to transfer their credits. That is, there is little available evidence to indicate the degree of leakage (i.e., students losing credits) that occurs when a student transfers from one program to another. As a result, lateral transfer remains a problematic but potentially fruitful transfer pathway which deserves more attention.

Reverse Transfer: The Return Route

Reverse transfer is a process which allows students at four-year institution to earn an associate's degree. Reverse transfer programs are most commonly intended for students who started at a community college and transferred to a four-year institution without earning the associate's degree (OCCRL, 2015; Colorado Department of Higher Education, 2015). In US higher education, reverse transfer is receiving a considerable stimulus at the result of the Credit When It's Due (CWID) initiative, a national grant program designed to facilitate the implementation and improve the process of reverse transfer degree programs. CWID is a joint venture of several foundations who have awarded grants in 15 states for reverse transfer programs.

Reverse transfer can offer several significant benefits to students and institutions. Students benefit by achieving a milestone that encourages the acquisition of the baccalaureate degree; they also gain an edge in the workforce by having a recognized credential, especially in cases where they are unable to complete the baccalaureate. On the institutional side, reverse transfer programs strengthen institutional partnerships, demonstrate commitment to students' success, and can contribute significantly to degree completion efforts at the state level (Marling, 2012).

Some of the reverse transfer programs currently in place appear to be very extensive. For instance, Colorado's "Degree within Reach" program involves 29 Colorado institutions at the two- and four-year levels. However, it appears that Colorado's program is limited to earning more general degrees such as an Associate of Arts, Associate of Science, or Associate of General Studies (Colorado Department of Higher Education, 2015); it does not appear that it is possible to earn an associate's degree in cybersecurity at this time in Colorado.

Reverse transfer programs available in cybersecurity also appear to be in short supply nationwide, although the University of Maryland University College offers one (UMUC, 2015a). Visibility and transparency are also issues with this type of transfer pathway; information on available options is not readily attainable. Available research indicates that reverse transfer suffers

from some problems, including low completion rates (Hossler et al., 2012). Still, reverse transfer is also a potentially fruitful transfer pathway which deserves more attention.

Promising and Potentially Exemplary Transfer Practices

At present, research is still in the initial stages to identify promising and potentially exemplary transfer practices in cybersecurity education. Research to date has identified several promising practices worthy of closer examination:

Credit Transfer Tool -- This tool provides a list of previously evaluated courses for transfer, which enables students to figure out if their course(s) have already been previously accepted for transfer at into one of Wilmington University's undergraduate programs (Wilmington University, 2015).

Maryland Community College Alliance Partnership -- University of Maryland University College's Alliance program provides a single curriculum plan for earning an associate's degree and a UMUC bachelor's degree. The program is designed for Maryland community college students at the start of their associate's degree coursework; UMUC will accept up to 70 applicable community college credits from a Maryland community college (UMUC, 2015b).

2 1/2 + 1 1/2 articulation agreement -- Wilmington University allows students to transfer up to 75 credits for its computer and network security program (as well as other academic programs).

It is also possible that other promising transfer pathway models and practices will emerge. For instance, existing structures such as stackable credentials and the National Cybersecurity Workforce Framework could enable cybersecurity programs to take advantage of the growing interest in competency-based education (CBE) at colleges and universities. CBE could become a distinct form of transfer pathway or enhance the effectiveness of other existing transfer pathways. Another example could be a greater use of online or blended degree completion options to create new transfer pathway options, particularly for "place bound" students with limited locally available choices.

Improving Transfer Pathways for Cybersecurity Education Students

The criticisms of existing transfer pathways also contain the description of ways to create an effective, even exemplary transfer pathway system for cybersecurity education. Such a transfer pathway system would:

- Provide students with enough information about the transfer process so that they can

make informed choices;

- Develop clear, comprehensible policies for transfer of community college credits;
- Simplify the process of satisfying admission requirements to four-year institutions;
- Provide institutional incentives to support this transfer process;
- Minimize the loss of transfers and transfer credits;
- Provide continuous financial aid support for transfer students;
- Continue to explore, elaborate, and resolve the differences and conflicts between the academic cultures of two- and four-year institutions which hamper transfer students

Perhaps the two most important elements of such a transfer pathway system would be transparency and support. These two characteristics may seem to be contradictory, but in fact they are complementary. Transfer pathway systems need to be as transparent as possible to make the transfer process and available transfer choices much clearer, while at the same time providing support services for students who need them.

One promising route to do this would be to build one or more transfer pathway models which adopt and adapt promising transfer pathway practices more widely and frequently in cybersecurity education. However, even the most promising transfer pathways practices are not as transparent as they could be. There needs to be additional work to build a model which not only incorporates existing best practices but improves upon them. Components of such a model might include a clear degree map consisting of diagrams, maps, or other ways to visually represent transfer pathways and their key characteristics; a graphic visual of courses needed such as the one used in the Tennessee Transfer Pathways program; a Credit Transfer Tool (perhaps with more refined drill down capabilities) such as the one which Wilmington University uses; and a broader application of articulation agreements such as the one UMUC has with Maryland community colleges, perhaps expanded to include two-year colleges nationwide. Follow-up work related to this document will explore the feasibility of doing initial work (exploratory, pilot building, proof of concept) on creating a model transfer pathway. Another possibility worth exploring is to create transfer pathways in cybersecurity education that are themselves exemplary and worthy for other disciplines to emulate or adapt.

Another activity worth pursuing is to identify, disseminate, and recognize effective practices in cybersecurity education relative to transfer pathways. The cybersecurity education community could be involved in the process of creating appropriate criteria for identifying effective practices as well as in supplying examples of effective practices related to transfer pathways in cybersecurity education. Such a program could be sponsored and housed at the National CyberWatch Center. An effective practices program could also be supported with an awards program for the most exemplary effective practices, as is commonly done by other organizations in other disciplines and fields.

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