Spring 3-2018

CONSTRUCTING A CONNECTED PROGRAM IN IT/IS: A NON-R1 UNIVERSITY CASE

Xiang Liu
Marymount University, xliu@marymount.edu

Diane Murphy
Marymount University, dmurphy@marymount.edu

CONSTRUCTING A CONNECTED PROGRAM IN IT/IS: A NON-R1 UNIVERSITY CASE

Xiang (Michelle) Liu
Marymount University
xliu@marymount.edu

Diane Murphy
Marymount University
dmurphy@marymount.edu

ABSTRACT

A connected program model is developed in a non-R1 university to address the skill gap in the current Information Technology (IT)/Information Systems (IS) workforce. The program aims to enhance undergraduate IT/IS education and research to equip graduates with employability and soft skills to enable them to meet emerging challenges in an ever-changing global environment. The model integrates six dimensions of connectivity including 1) academia to industry, 2) curriculum over time, 3) students to research projects and researchers, 4) across disciplines and the world, 5) students with students and alumni, and 6) students with faculty. The paper starts with examining what skill gaps are in the current IT/IS workforce, followed by an outline of the primary framework –the connected curriculum. The third section presents a case study illustrating how the authors developed and implemented the program in their university. The discussions and future research directions are included in the last section.

Keywords

Connected curriculum, IT/IS program, skills gap, cross-disciplinary, undergraduate research, soft skills, workforce readiness

INTRODUCTION

Concerns continue among hiring managers and business leaders about the skills gap in the current workforce (e.g., Northeastern University, 2014). One of these concerns is in the soft skills of college graduates such as critical thinking and written communication believed to be vital for sustained, successful careers (Hamilton, Carbone, Gonsalvez, & Jollands, 2015; The Council for Aid to Education, 2016). Many college graduates appear to be entering the workplace without enough of the "employability factors" such as working in a team, oral and written communication, problem solving and self-management (Archer & Davison, 2008). The 2016 McGraw-Hill Education Workforce Readiness Survey further corroborated this by revealing that only 21% of undergraduates felt "very" prepared to join the workforce and 67% felt that their workforce readiness could be improved (Hanover Research, 2016).

The information technology and information systems (IT/IS) industry embodies a constantly changing and intensely competitive environment with high expectations for graduates entering the industry. Both industry and academia recognize that skilled young workers are critical drivers for innovation, the development of new technologies, and maintenance of a sustainable and changing knowledge base. Hence, the inherent nature of the IT/IS discipline poses challenges for educators to cover the knowledge body associated with continuous change in subject matter and to develop the necessary "employability factors" in their students. This changing workplace environment in technology requires IT/IS academic programs to incorporate emerging and relevant resources and skills that prepare students to be career-ready and competitive in a global economy where the jobs may be unknown (College for Every Student (CFES), 2016; Forshaw et al., 2016).

Employers expect graduates to possess an array of cognitive, applied and interpersonal skills as well as up-to-date technical capabilities (Radermacher & Walia, 2013; Tymon, 2013). How do we balance the teaching of the core theories and increasingly complex body of knowledge while equipping students with soft skills so that they will succeed along their career pipeline? To close the gap, colleges need to effectively engage with employability skill development. This paper aims to address the disparity between industry expectations and many existing IT/IS programs using connections between the various stakeholders throughout a student's educational journey. The proposed program is based on Fung's (2017) connected curriculum framework, adapted in a non-R1 university setting. The next section will outline the primary framework that guided our approach, encouraging close relationships between faculty and students. The third section presents a case study illustrating how we developed and implemented the program in our university setting, focusing on employability skills integrated into the curriculum. The discussions and future research directions are included in the last section.

OVERVIEW OF THE CONNECTED CURRICULUM FRAMEWORK

Our IT/IS program uses the six-dimension connected curriculum framework proposed by Fung (2017). The main purpose of the framework is to promote best practices in higher education institutions and foster creative ideas for enriching the curriculum and student experience. As illustrated in Figure 1, by highlighting the reciprocal relationship between education and research, the framework interconnects different sectors of inquiry and disciplines to enhance the quality of education as well as enrich research itself. As an example, University College London (UCL), a large research- intensive university in the UK, has adopted this framework, and it has become an integral part of its published education strategy (UCL, 2016).

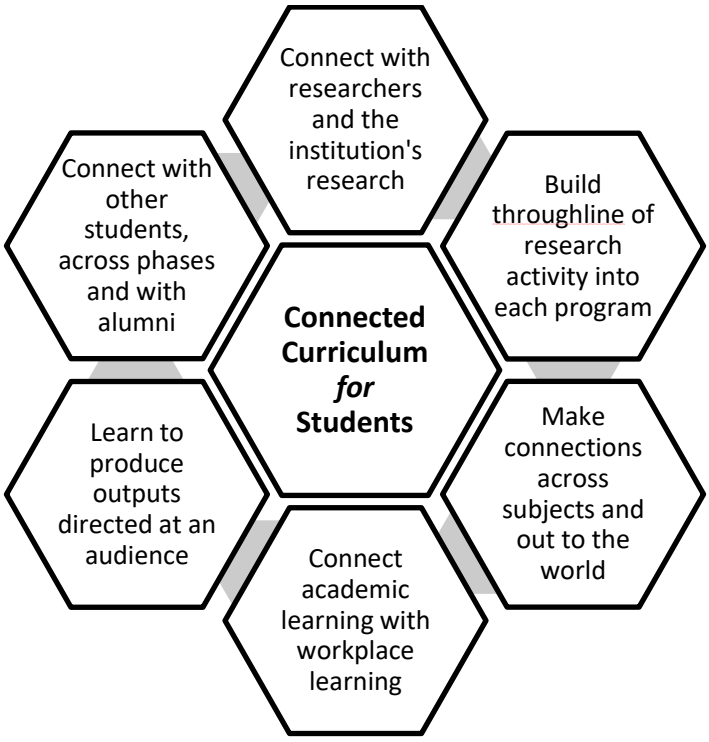

Figure 1. The Connected Curriculum (Adapted from Fung (2017))

The six dimensions of the framework are summarized below:

- **Students connect with researchers and with the institution's research**: focuses on facilitating connection between students and researchers and engaging students with real-world research projects;
- **A throughline of research activity is built into each program**: calls for deliberate program design to empower students with a connected sequence of learning activities (knowledge and skills) throughout their learning journey;
- **Student make connections across subjects and out to the world**: focuses on creating cross-disciplinary programs that emphasize global perspective and service to society;
- **Students connect academic learning with workplace learning:** focuses on equipping students with the capability to connect and apply academically learned knowledge and skills to both the workplace and lifelong learning;
- **Students learn to produce outputs- assessments directed at an audience:** focuses on reinforcing experiential learning through engaging students with real-world problems and external audiences; and
- **Students connect with each other, across phases and with alumni:** focuses on diverse students connecting with one another across their class and other phases of study, learning from each other.

CONSTRUCTING A CONNECTED PROGRAM IN IT/IS

Our university is a small liberal arts teaching institution with a diverse student population of approximately 3,400 undergraduate and graduate students (68% female, 14% African American, 15% Hispanic, and 8% Asian/Pacific Islander). We have about 400 IT/IS students, including undergraduate and graduate. Many IT/IS students are working professionals, one-third of the students are first-generation college students, and transfer students from community colleges comprise almost one-half of the undergraduate population. We adapted Fung's connected curriculum framework (2017) to this non-research university setting,

with a focus on career preparation, and including the critical thinking development during the research process. We enumerate six dimensions of connectivity being developed and implemented in the IT/IS program. Figure 2 illustrates the interconnection between these dimensions as shown below. Each dimension is discussed below.

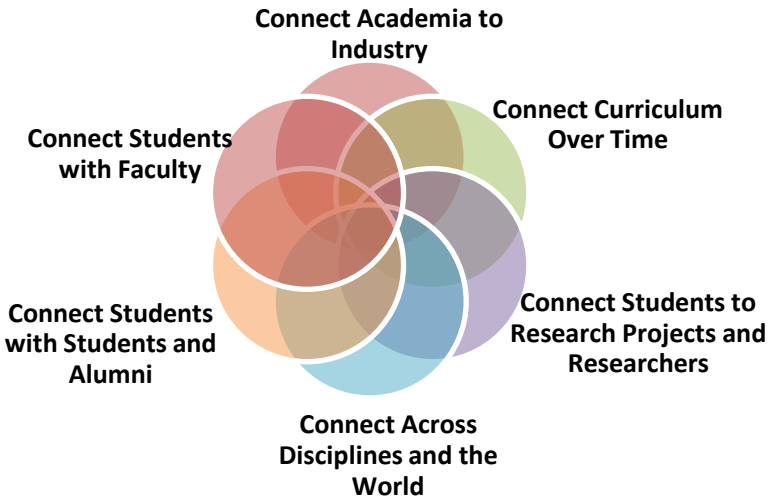

Figure 2. A Connected Program Model

Dimension 1: Connect Academia to Industry

One of the major outcomes from a degree program is to prepare students for the next step in their career, whether further education or a position in government or industry. There is little doubt of the importance of a strong connection between academia and industry such that graduating students reach their ultimate goal of meaningful employment. A previous study addressed the challenge of bridging the gap between employers' expectations and IT/IS graduates' employability (Liu & Murphy, 2017), in which the authors presented their workforce development framework and the need for faculty and students to be connected with industry. An important component on this framework is that the connection must begin in the student's freshman year and continue through and after graduation. It is not just a case of an internship in the senior year, students must be continuously engaged in the needs of their career path.

Dimension 2: Connect Curriculum Over Time

There is no doubt that we need to increase the funnel of technology workers. The Northern Virginia Technology Council (NVTC) produced a technology workforce needs assessment for the Greater Washington area[1], where our university is located. This study concluded that there is a severe regional shortfall in the available technology labor supply. Where are these technology workers to come from and how to attract more people into the pipeline? This dimension focuses on the need to connect individuals with technology careers from an early age and from diverse backgrounds. This is particularly important for young females, who may not be aware of the opportunities to build a better world through applying technology (Tulshyan, 2010). The government has recognized this need and is trying new approaches such as the Department of Labor's Registered Apprenticeship Program[2]. Colleges need to be aware of such initiatives as many have associated funding.

Dimension 3: Connect Students to Research Projects and Researchers

A study published by the Council on Undergraduate Research (CUR) identified that participation in undergraduate research with faculty contributes to student retention as well as helping to direct students toward specific career paths (Bowling, Bullen, Doyle, & Filaseta, 2013; Karukstis & Elgren, 2007). Students who participate in collaborative research with faculty also make significant gains in their critical and logical thinking skills (Keiler, Jackson, Jaworski, Lopatto, & Ades, 2017). Various studies confirm these findings, in many different fields including social sciences, the humanities, data science, and computer science

[1] http://www.nvtc.org/documents/NeedsAssessment.pdf
[2] https://www.doleta.gov/OA/apprenticeship.cfm

(Musabirov & Bakhitova, 2017; Stanford, Rocheleau, Smith, & Mohan, 2017). Cultivating a research culture with a sound academic foundation enables students to develop critical thinking skills along with effective oral and written communication skills (Rahman, Hu, Brylow, & Kussmaul, 2017). It also fosters creativity and innovation.

Dimension 4: Connect Across Disciplines and the World

While specialized expertise remains vital, students must be prepared for inquiry in a world where challenges are complex and profoundly interconnected (Lyall, Meagher, Gill, & Kettle, 2016). Gateways in the curriculum from one discipline to another enable students to examine their discipline through more educated eyes and empathetic angles. By opening up shared spaces for making inquiries about the world that draw on the content and practices of more than one discipline, students can develop the breadth and adaptability needed for a rapidly changing social, economic and global landscape (Fung, 2017). This is one of the principles behind a liberal arts education.

Dimension 5: Connect Students with Students and Alumni

According to Fung (2017), there are mainly three reasons to fostering networking and connection with other people who have varying backgrounds and perspectives. First, it contributes to the development of students' learning and specifically to their critical thinking skills. Second, working and meeting with other students and alumni builds active networks, creating a sense of belonging to a community and helping to prepare students for the complex social demands of life and the workplace. More fundamentally for the connected curriculum initiative, learning with and from others is more than just part of the educational process: it is one of the goals of education.

Dimension 6: Connect Students with Faculty

Students interact with faculty in various ways, primarily as professors but also in other roles such as advising and mentoring. Colleges must move away from prescriptive advising where faculty merely advise on what classes to take and fill-out forms. Descriptive advising involves a closer relationship between faculty members and their students and is designed to help students to excel in their educational, career, and personal goals. Schreiner proposes an extension of this so-called strengths-based advising (Schreiner & Andersson, 2005). This approach encourages faculty members to identify and build on the diverse talents that each student brings to college and to work with them to build the confidence and motivation for success in college and the future.

How Did We Implement A Connected Program?

As a catholic liberal-arts college, many of our university-wide programs support the idea of a connected curriculum. We have developed our IT/IS programs to take advantage of these initiatives and to integrate additional activities specific to our discipline. Many of these activities cover more than one of the dimensions shown above. For example, all our students are required to take the liberal arts core in fields such as business, social sciences, humanities, science, and philosophy/religion. This connects the students across disciplines and provides an excellent framework for their major-specific learning (Dimension 4). Many students do not see the value of courses in these other disciplines so IT/IS faculty must explain their importance to students. All students are also expected to take three writing-intensive courses as part of their program, in addition to the standard English courses required in their freshman year. In the IT/IS program we have incorporated them into our major curriculum so students have considerable experience in the type of writing they will need in the workplace.

We have built connectivity between our academic institution and industry as well as government throughout different phases of our program, inside and outside the classroom (Dimension 1). We bring in working professionals to talk to students about their workplace and their actual jobs. Some of this is in class (primarily through seminars in the sophomore, junior, and senior years) and in a variety of out-of-classroom events. We are affiliated with professional organizations such as the Information Systems Security Association (ISSA) and ISACA whose members come in and talk to students and participate in events focusing on resumes, networking, and interviewing skills. ISSA also offers a mentorship program for the students. In addition, these events provide a variety of opportunities for undergraduate students to network with our graduate students, many of whom in the IT professional workforce, and with recently-graduated alumni, also working in industry. This is an organic connection as they have the common platform, the university (Dimension 5).

All undergraduate students are required to take a for-credit internship as well as participate in a variety of other work experiences (Dimension 1). Faculty members play indispensable roles in the internship process as mentors, helping students identify good internships and preparing them for the interviewing process (Dimension 6). As a catholic institution, we promote "service to others" as one of the university pillars, which students are encouraged to volunteer in a variety of activities to support the university, local not-for-profit, and small business communities. Faculty and alumni play an important role in this area also (Dimensions 5 and 6).

Another pillar of the university's educational mission is global awareness. Our student population, as well as our faculty, are very diverse, therefore, classroom group activities developed for each IT/IS major course prepare students for the IT workplace (Dimension 4). We also take students on global experiences, recent visits include Estonia, Finland, Canada, and Ireland. These experiences broaden their perspective of the global workplace and the competition faced by overseas organizations (Dimension 4). Some students also elect to do their internship in a different country, recently IT students have interned in England, Ireland, Australia, Spain and Italy.

However, it is not just the work with our students. We have been active academic advocates in promoting IT and cybersecurity knowledge and awareness throughout all age groups (Dimension 2), including teaching potential technology workers from middle and high schools, particularly females. These students are avid "users" of technology but rarely "creators" of that technology. We, therefore, ran summer camps to teach them how to develop mobile apps, so demystifying application development (Dimension 4). We also have participated in the NSA GenCyber program, running a series of cybersecurity camps for middle and high school students (www.gen-cyber.com). These camps are run on college campuses and allow students to work together as they would at a university or in the workplace (Dimension 2).

However, to significantly increase the technology workforce we must also look at other sources of workers. At our university, the faculty work with the local community colleges to encourage students who are taking a general education associates degree to continue in a technology field (Dimension 2). About 50% of our IT students come from local community colleges, many starting at community college without a specific career in mind. Another source of technology workers is the veteran community, many of whom have good technology skills based on the training in the various services. Our connected program is aligned with the university's veterans' program, including the Yellow Ribbon designation (Dimension 2).

We keep a balance between teaching practical skill and toolsets and maintaining a current and relevant research portfolio with dedicated faculty research collaborators (Dimension 3). Traditionally research-focused universities (like an R1) have many innovative research projects and offer many research activities for undergraduate students. Some of these are funded by the National Science Foundation (NSF) under the Research Experience for Undergraduate (REU) program. What about the smaller non-R1 universities? Our non-R1 university began a college-wide initiative called "Discover" to foster undergraduate student research about 10 years ago. The Discover program enhances our connected program by promoting student research, beginning in the first year of college (freshman and transfers). The program crosses disciplines (Dimension 4) and students can select their own topic area. The undergraduate research activities continue through the whole IT/IS curriculum, with a strong emphasis on information literacy and data literacy. Students who want to pursue a subject in more depth can take an elective research course with an individual faculty member (Dimensions 3 and 6), at any time in their program. Finally, all undergraduate IT students take a final capstone project in their senior year which can be a research project with a specific faculty mentor.

We continue to find ways for faculty and students to connect, inside and outside the classroom. One area of growth is to make the results of our technology projects and research known to the rest of the university and our local businesses and government agencies. In Spring 2018, we will begin a competitive TechExpo to enable students to present their technology to a wider audience (Dimensions 1 through 6).

CONCLUSION

We believe that this connected curriculum approach in our IT/IS program is instrumental in helping us meet our program outcomes: an increased number of students entering the workforce with both technical and soft skills including critical thinking, problem solving, team work, oral and writing communication, and others. One distinctive nature of our connected program is adaptive and evolving to reflect on the emerging technologies and dynamic landscape of the IT field. Beginning next semester, a new alumni initiative (Computing Alumni Network) will give each student a working mentor in their specific field of study, from system development to cybersecurity. We are continuing to engage more students in undergraduate research and encouraging them to present at the university's Student Research Conference, the TechExpo, and professional events.

We stress the need to increase the technology pipeline, particularly for females. Our current undergraduate IT program is over 30% female and our faculty members, as role models, are 60% female. We will continue to provide outreach to students in the educational pipeline, connecting more college students with younger students in these outreach efforts.

Formative evaluation of the program have been conducted during the different phases of the program through informal conversations with current students and graduates, periodic roundtable meetings with students and alumni on the job market, and faculty feedback on any curriculum updates in monthly department meetings. The vehicle for summative evaluation of program is five-year evaluation conducted by an external evaluator based on an onsite visit and interviews with the faculty and students. One of the future research directions is to broaden participation of stakeholders in the program assessment process including employers. We also plan to track the employment of our graduates over the last five years to collect "employability"-related data for further analysis and reflection.

REFERENCES

1. Archer, W., & Davison, J. (2008). Graduate employability: What do employers think and want? Retrieved from https://aces.shu.ac.uk/employability/resources/0802Grademployability.pdf
2. Bowling, B., Bullen, H., Doyle, M., & Filaseta, J. (2013). *Retention of STEM majors using early undergraduate researchexperiences*. Paper presented at the Proceeding of the 44th ACM technical symposium on Computer science education, Denver, Colorado, USA.
3. College for Every Student (CFES). (2016). New Dimensions of College and Career Readiness: Implications for Low-Income Students. Retrieved from http://www.collegefes.org/pdfs/16-0460%20New%20Dimensions%20white%20paper%5B2%5D.pdf.
4. Forshaw, M., Solaiman, E., McGee, O., Firth, H., Robinson, P., & Emerson, R. (2016). *Meeting Graduate Employability Needs through Open-source Collaboration with Industry*. Paper presented at the Proceedings of the 47th ACM Technical Symposium on Computing Science Education, Memphis, Tennessee, USA.
5. Fung, D. (2017). *Connected Curriculum for Higher Education* (1st ed.). London, England: UCL press.
6. Hamilton, M., Carbone, A., Gonsalvez, C., & Jollands, M. (2015). *Breakfast with ICT Employers: What do they want to see in our Graduates?* Paper presented at the Proceedings of the Seventeenth Australasian Computing Education Conference (ACE2015), Sydney, Australia.
7. Hanover Research. (2016). McGraw-Hill Education 2016 Workforce Readiness Survey. Retrieved from https://s3.amazonaws.com/ecommerce-prod.mheducation.com/unitas/corporate/ideas/2016-student-workforce-readiness-survey-expanded-results.pdf
8. Karukstis, K., & Elgren, T. (Eds.). (2007). Developing and Sustaining a Research - Supportive Curriculum: A Compendium of Successful Practices. Washington, DC Council on Undergraduate Research.
9. Keiler, K. C., Jackson, K. L., Jaworski, L., Lopatto, D., & Ades, S. E. (2017). Teaching broader impacts of science with undergraduate research. [Article]. *PLoS Biology, 15*(3), 1-8. doi: 10.1371/journal.pbio.2001318
10. Liu, X., & Murphy, D. (2017). Are They Ready? Integrating Workforce Readiness into a Four-Year College IT/IS Curriculum. *The Proceedings of 20th SAIS (Southern Association for Information Systems Conference)*. Retrieved from http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1007&context=sais2017
11. Lyall, C., Meagher, L., Gill, B. J., & Kettle, A. (2016). Interdisciplinary Provision in Higher Education. Retrieved from https://www.heacademy.ac.uk/system/files/interdisciplinary_provision_in_he.pdf
12. Musabirov, I., & Bakhitova, A. (2017). *Trajectories of student interaction with learning resources in blended learning: the case of data science minor*. Paper presented at the Proceedings of the 17th Koli Calling Conference on Computing Education Research, Koli, Finland.
13. Northeastern University. (2014). Innovation Imperative Series. Retrieved from http://www.northeastern.edu/innovationsurvey/#survey
14. Radermacher, A., & Walia, G. (2013). *Gaps between industry expectations and the abilities of graduates.* Paper presented at the SIGCSE '13.
15. Rahman, F., Hu, H., Brylow, D., & Kussmaul, C. (2017). *Bringing Undergraduate Research Experience in Non-R1 Institutions*. Paper presented at the Proceedings of the 2017 ACM SIGCSE Technical Symposium on Computer Science Education, Seattle, Washington, USA.
16. Schreiner, L. A., & Andersson, E. (2005). Strengths-Based Advising: A New Lens for Higher Eduation. *NAACADA Journal, 25*(2), 22-29.
17. Stanford, J. S., Rocheleau, S. E., Smith, K. P. W., & Mohan, J. (2017). Early undergraduate research experiences lead to similar learning gains for STEM and Non-STEM undergraduates. *Studies in Higher Education, 42*(1), 115-129.
18. The Council for Aid to Education. (2016). CLA+ National Results, 2015-2016. Retrieved from http://cae.org/images/uploads/pdf/CLA_National_Results_2015-16.pdf
19. Tulshyan, R. (2010). Top 10 College Majors For Women. Retrieved from http://www.forbes.com/2010/03/02/top-10-college-majors-women-forbes-woman-leadership-education_2.html
20. Tymon, A. (2013). The student perspective on employability. *Studies in Higher Education, 38*(6), 841-856.

UCL. (2016). Education Strategy 2016– 2021 from https://www.ucl.ac.uk/teaching-learning/education-strategy