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Supporting Student Attainment and Management of Competencies in a Transdisciplinary Degree Program

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Abstract
In Fall 2014, a large Midwestern land-grant research university piloted a competency-based model as the foundation for an undergraduate transdisciplinary program focusing on connecting engineering and technology with humanities and social sciences. Students enrolled in this program progress through a set of competencies that require them to master cross-disciplinary and cross-functional skills needed to be successful in a 21st century workplace. Now in its second year, the competency-based program has undergone significant changes that include a more substantial definition of competencies at each of the three levels of competence (developing, emerging, and proficient), scaffolding needed to support students on their path towards gaining competencies, and significant mentoring by faculty, TAs, and professional advisers to support competency attainment.

In this paper, we will share challenges and discoveries made by the faculty throughout the first two years of the novel Competency-Based Education (CBE) experience, including a reflection on how such experiences impacted modifications of the CBE model from Year 1 to Year 2, the ways in which the program supported individual attainment and management of competencies by students, and the value of the mentorship program in supporting student-driven learning paths. We will also share insights into students' perceptions of the benefits, challenges, and frustrations of being part of this pilot program based on interview and survey data provided by the 33 members of the initial cohort. This overview of the ways this program supported students in attaining competencies through coursework, individual mentoring, and scaffolding may be instructive as institutions seek to bring CBE to scale and increase holistic student learning for the 21st century.

Introduction

There is growing interest in Competency-Based Education (CBE), with approximately 600 institutions of higher education offering or currently designing competency-based programs.[1] CBE shifts learners' focus from credit hours and seat-time to what each learner *knows and can do*, increasing the connectivity between school and future jobs.[2] Instructional time is focused on content mastery, rather than attainment of credit hours, and has been previously linked to higher standards for student learning.[3]

Background / Literature Review

While CBE has been in the spotlight in the recent years, it is not a new instructional paradigm. First introduced by the Carnegie Foundation for the Advancement of Teaching in 1906, it was popularized in the United States in the 1960s and 1970s in response to the National Defense Education Act,[4] and later adopted during the performance-based vocational teacher education movement.[5] Over time, CBE has moved from a goal-oriented behavioristic approach to a characteristically holistic approach that requires the integration of knowledge, skills, and attitudes.[6]

CBE returned as a model for higher education several decades after popularity of this approach had waned, particularly in engineering and technology domains. This can in part be explained by the growing gap between the academic curriculum and the needs of the labor market. With the rise of globalization and rapid development of technology, engineering and technology students must constantly update their knowledge and skills once they are on the job to ensure that they remain competitive.[7,8]

A competency-based educational experience "derives a curriculum from an analysis of a prospective or actual role in modern society and that attempts to certify student progress on the basis of demonstrated performance in some or all aspects of that role".[9] The broad definition offers much freedom as to how the CBE models are employed or even named. For example, some institutions refer to them as assessment or concept-based programs, or personalized learning. While there is variation among these approaches in terms of scope, intentions, or theoretical framework, the overarching agreement is that skills, abilities, and behaviors acquired should be measurable and attainment of milestones is skill-based (as opposed to time-based used in traditional programs).[10] CBE programs aim to increase the ability of students to succeed in their professional lives,[11] encouraging students to develop patterns of knowledge acquisition and knowledge application, making students lifelong learners.

Similarly, there is a misalignment in the use of "competence" and "competency" when describing approaches. The main distinction between the two terms is that "competence" implies the demonstration (or process) of knowledge, skills, and attitudes, whereas "competency" suggests the description of such knowledge, skills, and attitudes.[12]

There is no unified agreement as to how to approach competencies as part of a pedagogical model. An argument in research literature is ongoing as to whether it is necessary to completely overhaul programs and knowledge and skills taught to allow for the identification and mapping of competencies that may be valuable in today's workplace, or whether educators should carefully synchronize competencies based on their purpose and context, while paying particular attention to the dimensions of competence (e.g., hybrid and context-dependent professional dimensions) and elements of competence (e.g., theoretical foundation, analytical elements applicable across competencies).[13]

Currently, two models dominate the approaches for implementing CBE in the United States: 1) a competency framework applied within an existing course based model, and 2) competency frameworks that drive curricular redesign. Schools that chose to follow the course-based model include Rio Salado College, Brandman University, and Marylhurst University. These programs also use traditional credit models, where students fulfill graduation requirements by earning a set number of credit hours. In a full, program-level competency framework, graduation requirements are met by fulfilling competencies rather than specific courses or credit hours.[14]

There are numerous potential advantages of utilizing CBE as a model for higher education programs that could be grouped as follows:[10]

- ***Learning processes***
  - *Student-centered or student-led learning:* while students work with mentors to outline their individual academic paths, they are ultimately responsible for the selection of and adherence to a learning path.
  - *Personalization of education:* students are able to focus on competencies that would help them differentiate themselves in a competitive labor market.

- *Validation of extracurricular and/or prior learning and experiences:* learning is not constrained to that being acquired within a traditional classroom environment.
- *Clear expectations and relevance of work to the ultimate academic goal:* competency maps create cohesive and transparent program sequencing that allow students to have a clear view of the direction and requirements for their learning.

- ***Program design and implementation***
  - *Measurability and quality:* competency maps and clear competency descriptions allow for clear assessment of student achievement and outcomes.
  - *Transparency:* faculty commitment to regularly informing students about requirements and continuous program improvement as a joint effort, particularly, since explicit agreement should be reached in terms of competency achievement.
  - *Accountability:* engagement of industry experts and outside evaluators to ensure the relevance of skills and knowledge taught.
  - *Improved metrics:* the level of benchmarking granularity to ensure performance and competency achievement at each level.
  - *Affordable education:* elimination of redundancies across domains, embedded assessment, and validation of external learning enable a reduction in the financial burden on students and their families.
  - *Flexible curriculum:* a shift towards demand-driven education allows the faculty to focus on being facilitators of learning.[2]
  - *Mentoring and coaching:* flexible curricula allow faculty to work with individual students and develop stronger learning domain and soft skills than may be possible within a traditional educational model.[2]
- ***Student learning and professional outcomes***
  - *Clear and verifiable descriptions of students' knowledge, skills, and abilities:* unlike a traditional transcript that does not show outcomes for classes, only competencies acquired by students are reflected.
  - *Lifelong learning skills*: the ability to curate learning paths throughout their academic career help students develop skills for ongoing learning.[15]

There are challenges in the adoption of CBE. The lack of a unified model allows institutions to tailor the CBE framework to their individual needs. At the same time, this ambiguity requires faculty and program designers to start from point zero, thus resulting in obstacles to CBE adoption within the institution. In this paper, we will describe the path we have taken, challenges met, and lessons learned when designing a competency-based transdisciplinary undergraduate program.

Program Background

The Transdisciplinary Studies in Technology (TST) program was initiated in Fall 2013 at a large Midwestern university with a call for interest among faculty of the home college (Technology), which was supplemented a few weeks later with a broader call for interest by faculty across campus. A letter of interest and interview were expected from all interested faculty. With an initial cohort of faculty identified, a series of 10 weekly meetings on change philosophy and practice took place during the first semester. By Spring 2014, a team of 15 multi-disciplinary faculty solidified their role as part of the Educational Research & Development Incubator. These faculty fellows are drawn from schools and departments around campus including education, communications, English, technology, theater, and the libraries. Since the early stages of the initiative, faculty fellows have been involved in establishing the administrative framework along with the pedagogical architecture and curricular foundation of the program.[16] This program is the first competency-based undergraduate program on this campus and is an accredited degree option as of Spring 2016. The program is designed to enable students' progress through sets of competencies that allow them to individualize their educational experience, while mastering a core set of transdisciplinary skills to meet the needs of a 21st century workplace, culminating in a unique degree.

In Fall 2014, the program welcomed the first cohort of 33 students with diverse technical and engineering interests, including mechanical engineering and technology (33.3%), computer and information technology (16.7%), computer graphics and technology (11.1%), aviation (8.3%), and building and construction management (5.6%) among others. Additionally, 19.4% did not identify their interest by the beginning of the semester. The majority of students were males (83.3%). Students came from diverse ethnic background. Overall, the demographic composition of the first cohort aligned with that of the college. Finally, all students self-identified their past academic success within the "A" to "B" range.

The faculty fellows developed a set of values to ensure that an overarching goal of preparing a new generation of technologists and engineers was achieved:[17,16]

- Student as a whole person: to support students in their development of individual talents, increase their understanding of the world, and develop skills to be a productive member of society.
- Diversity of thinking, knowing, and learning: to sustain divergent and convergent thinking, cognitive and embodied knowing, and theoretical and experiential learning.
- Openness, collaboration, and cooperation through collaborative learning, production, and consumption of knowledge: to help students embrace the creative powers of the community.
- Access to all students: to nurture and support all talents and sensibilities from diverse backgrounds, means, preparation, and experiences.
- Students' autonomy: to ensure that learning becomes a personal act of discovery enriched by strong motivations and commitment.
- Risk taking: to maintain open-ended inquiries, encourage learning from failure, and develop courage, creativity, and competence.

The program aims to integrate technical and liberal arts domains to support students' exploration and interconnectivity of transdisciplinary action beyond traditional academic experiences. From the first semester, students begin operating in an environment that encourages learning-by-doing experiences, while allowing them to address ill-structured authentic problems. The skill-based CBE approach allows students to focus on acquiring competencies and personalizing their educational and experiential path with an ongoing support from a mentor.

The development of a competency-based educational model for the program has been challenging on many levels, requiring the faculty to continually evaluate and modify the program to ensure that CBE principles, transdisciplinary experience, and program values were upheld, while functioning within the existing university structure.

Incubator CBE History—Year 1

The first cohort of students were admitted into traditional majors within the college of technology and chose to try the new CBE program. The TST program offered two courses each semester, a seminar-style class and a design lab, in which the first cohort of students enrolled. Tracking student development of competence was accomplished using a badge system, Passport, developed within the University. The Passport system is built on the Mozilla Open Badge Initiative (OBI) platform.

In the first year, the faculty in the two core courses developed badges that encompassed the learning outcomes of each course. The seminar course, titled *Digital Narratives*, was worth seven credit hours and encompassed and extended the content of the typical first-year English and Communications classes required of all students. As such, the learning outcomes were mapped to those two existing university classes. The second course was a design lab experience where students were introduced to the design process, given an open-ended problem statement, and allowed to determine and prototype their own solution. This extended the typical first year introduction to design for the students in technology by incorporating the build portion of design. Both courses were taught in a studio model, where class time encompassed both short, lecture-style content delivery, discussions on content and concepts, and time for students to work.

Digital badges were used to track student work and subsequent completion of the learning outcomes for the two courses. Each learning outcome was articulated as a specific badge and each was envisioned to account for approximately one credit hour worth of work. Thus, the content that was parallel to the first year communications class, a three credit hour class, had three badges that housed the student deliverables as challenges that needed to be met. All of the badges created for this first year within the seminar class included between three and five challenges that needed to be met for a badge to be earned. Similarly, there were four badges to encompass the four credit hours' worth of work to be completed in the design lab experience.

The faculty strove to embody the core tenets of CBE: allowing students to work at their own pace, submitting materials multiple times with revision until the expected level of work was demonstrated. To accomplish this goal, students were given suggested due dates, but no penalties were assessed for late work. This resulted in many students waiting until late in the semester before submitting work, and not leaving time for the multiple rounds of revisions often necessary to bring the student work to the expected level of achievement. This was particularly problematic, since the faculty had agreed that achieving the competency equated to "A" level work, and anything below that was returned for revision. A more detailed look at this process and the lessons learned can be found in Evans, et al.[18]

Beyond the two new classes, students were able to complete the equivalent content of the required introductory class in the discipline of their matriculated major using an independent study model that was tracked via earning the three or four badges that encompassed that content. The disciplinary badges and associated challenges and tasks were created by disciplinary faculty who had previously taught the equivalent courses.

In the second semester several things changed, primarily due to changing faculty personnel availability. As such, the seminar course became a more typical discussion-based topics class worth two credits, and the design lab class was substituted with a construction management course which included both lecture and a hands-on team-based lab experience. During this semester, the faculty fellows of the transdisciplinary degree began to realize that the initial model for creating badges to parallel course learning outcomes would not be sustainable. Badge development would depend on the work of faculty who are not members of the transdisciplinary degree faculty fellows, particularly for coursework outside of the degree-required design lab and seminar courses. It was unrealistic to expect or require use of badges that follow the TST model from faculty in other departments and colleges where students would be taking classes to meet the university core curriculum, such as psychology, advanced writing, or math and science courses. Additionally, in its initial construction, it was unclear what badges or competencies a student would need to achieve for degree completion, or how to certify a particular level of mastery of content. Finally, the frustrations of trying to fit a classic competency framework program inside the existing structure of a traditional research-intensive university was almost impossible, particularly with regard to required satisfactory academic progress markers used for financial aid and scholarship determinations,[19] as well as transfer between programs, all regulated by the traditional credit hour and course structure.

Incubator CBE History—Year 2

The need to more clearly articulate the competency learning outcomes expected of the students led the faculty fellows to create a new competency framework and intentionally decouple badges from coursework. In this model, coursework can, and should, be used as a vehicle to produce artifacts that demonstrate the different competencies, but coursework is no longer directly tied to a particular badge or competency. This differentiates our program from other schools that implemented a course-based competency program. In a classic course-based CBE program, the coursework directly applies to badges. One potential problem with using badges comes if badges are automatically awarded with little or no assessment, also known as "carpet badging".[20] Students can turn in work and complete an assignment, but if that means they automatically receive a badge without intentionally striving to meet a goal or demonstrate competence in that particular skill, tying badges and coursework together could be perceived as carpet badging. We wanted to avoid this issue, which can also limit how students understand the ability to earn *additional* badges.

Our program-level competency model opened the door for students to document and submit competencies learned as part of courses other than those required for the transdisciplinary major, in addition to co-curricular activities that would not be captured or documented as part of a typical college transcript. This change simplified the work of building an understanding and acceptance of the degree with the campus registrar and other administrative offices, as it became possible to articulate the students' degree progress as a series of courses, similar to other majors, with the competency achievement certified outside of coursework. One drawback to this model was the students' perception that they are doing additional work to achieve the badges, since any coursework must be submitted for assessment via badges to meet the competency requirements.

The TST degree now articulates eight overarching competencies, with badges available to be earned at developing, emerging, and proficient levels (Figure 1). While the path through achieving the badges will be different for every student, the levels of achievement roughly equates to the skills that would be expected for first year students (developing), second and early third year students (emerging), and late third year and final year students (proficient). Students are not expected to reach the proficient level in every one of the sub-competencies articulated within the overarching eight competencies. There is room for students to determine what areas make the most sense for their own development and career plans, allowing them to create a path to the envisioned and desired future that fuels their desired areas of learning.

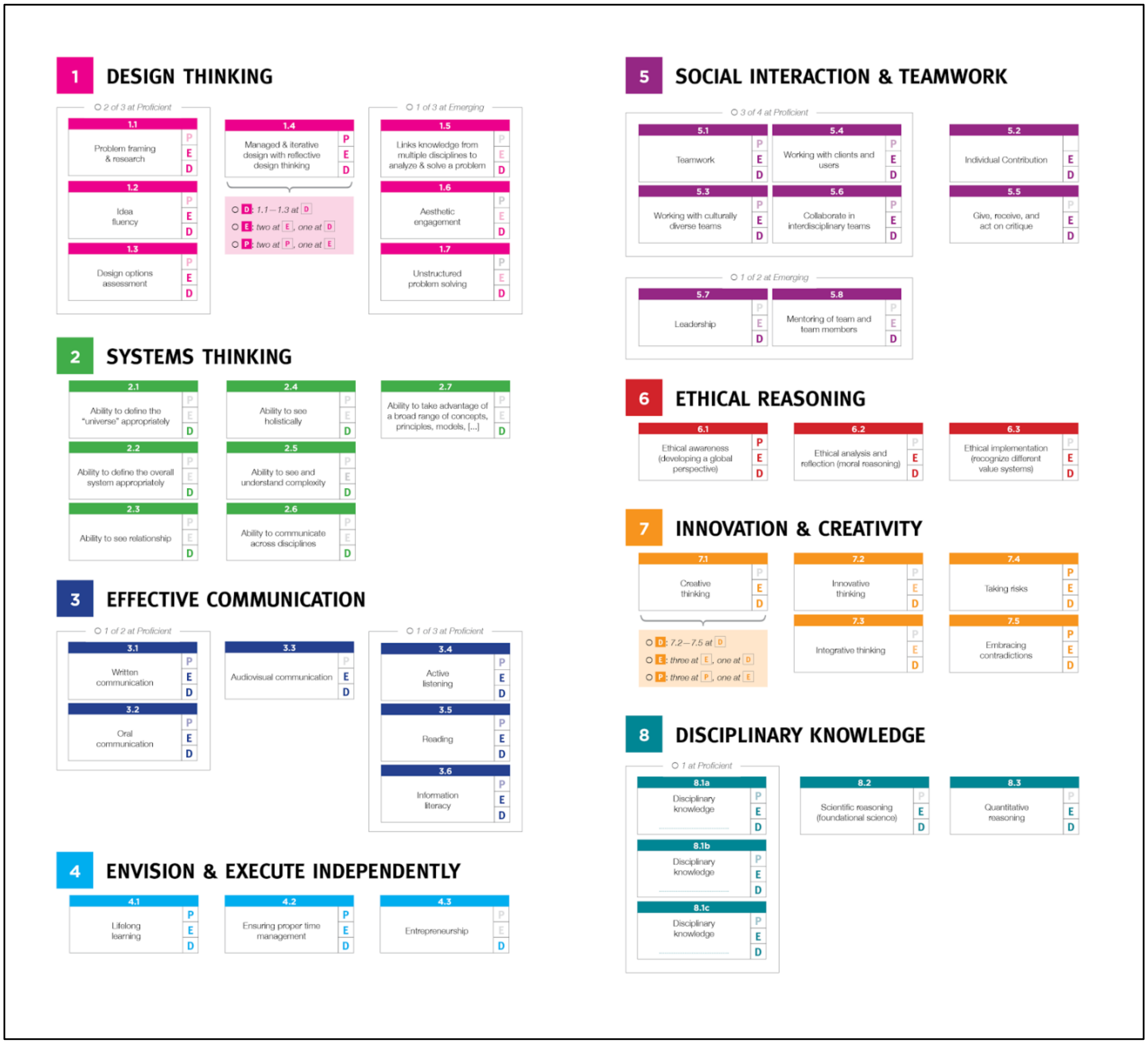

Figure 1. Competency map organized by overarching competencies with required badges to be earned at developing, emerging, and proficient levels.

From the student perspective, this change in thinking about competencies and methods for competency attainment resulted in some significant new challenges. When students started the program, the attainment of badges was coupled with completing course work, whereas in the new model, badges needed to be mapped and documented as a process outside of coursework.

Bringing students into this new model, and having them take ownership of creating their own degrees, including considering what competencies they are interested in achieving in a given semester, has been a substantial learning curve. Most undergraduate students are accustomed to having a learning path prescribed for them and represented as a series of courses, where they do not need to spend much or any time considering if this is the right or best path for them and the future they want. We are still working with students to guide them towards full understanding and embracing of the process of mapping their own path through college and what that means for courses and additional learning opportunities, be they study abroad, unexpected course pairings, or non-traditional learning experiences.

Ideally this process of having students map their own path and adjusting that path as the vision of their possible future becomes clearer helps the students discover and hone their own lifelong learning skills. The majority of working professionals learned that what they were taught during their undergraduate studies was simply a base to build upon, and once in the work world, there was no professor to tell them what to learn. Rather, it is up to each individual to determine what they need to learn to accomplish a particular task, requiring them to map the best path for gaining the knowledge and skills needed to complete the work.

Mentoring—Year 1

The faculty fellows agreed since the program planning began that a mentoring process needed to be part of this new degree. The importance of mentoring was established for two reasons: First, the Purdue-Gallup poll[21] showed a positive retention benefit for students who feel they had a good mentoring relationship during the undergraduate experience. Second, the faculty fellows as a group agreed that forming personal, out-of-class connections with the students were important to the development of the program identity and student success. In the first year, the mentoring process was envisioned to occur in groups of five students and two faculty. While this model allowed faculty to work with more students than a one-on-one model, there were significant scheduling complications in getting the groups together. In addition, the mentoring program was completely unstructured. With no requirements for meeting frequency or particular outcomes to be achieved as part of the interactions, there was no external motivation to get the mentoring groups together.

Beyond scheduling, not all of the faculty assigned as mentors were in the classroom with the students, and as a result some had a more difficult time making personal connections with their mentees. Even in those situations where both faculty mentors were part of the teaching team, there was no immediate traction for getting the mentoring groups together. A short outing at the end of the university orientation program allowed the mentoring groups to meet each other, but did not kick start any additional meetings or interactions. A few organic groups emerged during the semester, largely due to common interest and availability of a faculty member to help enable projects, but largely students were left without consistent faculty interaction that would be the hallmark of good mentoring.

Mentoring—Year 2

The change in program structure for the second year also brought with it a formal mentoring program. In the formal mentoring program, mentors are responsible for helping students understand the new competency model and badge attainment structure. It became the responsibility of the mentor to work with each student to develop a customized path for earning the badges, which is particularly important due to the separation of coursework from direct badge attainment. Mentors are also responsible for awarding many of the badges in accordance with an established rubric, and guiding the student through the path of getting "certification" from faculty outside the program on disciplinary knowledge and other skills where the mentor may not feel comfortable or appropriately knowledgeable to assess student work.

After having worked with the students for at least one semester, the faculty fellows were able to establish mentor: mentee partnerships that accounted for personalities, work styles, and professional goals of the students. For the first semester in this new model, the faculty generated the pairings to facilitate a rapid start to the program, getting students introduced to the model that had changed after their first year of study. The ideal end goal was for the students to select their own mentor, and we were able to implement this choice with the second semester of year 2, with all students being paired with their first or second choice for mentor.

The formal mentoring program includes several guided activities, where the mentors are given a worksheet or suggested tasks to move students to full understanding of the revised CBE program and facilitate thinking about the revised badge and competency process. Figure 2 shows a portion of such a guide sheet used to help students identify what competencies they are in the process of achieving in particular classes and determining what artifacts could be included in their portfolio of work and used to submit for the associated badge.

Activity (there is information after the chart, don't miss it):

Have a structured conversation with your protégé(s) that will complete the following chart. One for each student.

Starting with this semester, since it will be the most concrete example, and going one class at a time, have the student talk about the assignments or activities for each class and what they are learning with that activity. Help them draw the connections between the activity and the learning they are expressing and a particular competency.

Class	Activities/Assignments	Competency	Portfolio inclusion
EXAMPLE TECH 299 (Design Lab)	• Project description • Presentation of project • Fishbone diagram • Presentation to request funding • Weighted decision matrix • Final design • Plans for prototype • Prototype build • Final project presentation	• Written communication / problem framing • Oral communication • Ideation – keywords (IL) • Design options assess. / links knowledge across disciplines • Audiovisual communication • Active Listening • Teamwork • Individual contribution	• Team charter / project specification • Class presentations (recorded) • Ideation worksheet • Design options assess. • Plans / drawing for prototype • Active listening worksheets • Project notes from team meetings • Feedback forms / photos of work / ownership identified on pieces of documentation

Figure 2. Worksheet for determining competencies achieved in particular courses.

One challenge to the mentoring program has been varying levels of engagement from faculty fellows in the mentoring process, as evidenced by presence or lack thereof during designated community lunch opportunities set aside for mentoring. While we understand that faculty schedules are not always flexible, there was a noted lack of communication with the mentees and/or the mentoring program coordinator when a mentor would be missing from these events.

Lessons Learned

Much of what we have learned to date in this program is not surprising, particularly in hindsight. Looking back over the last three semesters, it is clear that changing models for awarding and tracking competencies partway through a program is difficult for students. Many of the students are still playing catch-up with the new model of competencies and badge submissions. In certain situations, the accountability to agreements made between faculty fellows on how and how often to engage in certain activities, such as mentoring, is not particularly high. There is collegiality between faculty fellows, and when a faculty member is working outside their home departments there is minimal accountability to each other to accomplish tasks. Finally, working within the existing university structure, while also encouraging students to meet externally established satisfactory academic progress, made creating an ideal CBE program where students learn completely at their own pace, largely untenable. The changes in the program made as we learned and progressed into the second year, particularly moving into a program-based competency model, have created a program that can exist within the structure of a traditional credit-hour based model. As pointed out by Johnstone and Soares:

> "Successful models demonstrate that competency-based education (CBE) can fit into existing campus structures, if certain principles are followed:
>
> - The degree reflects robust and valid competencies.
> - Students are able to learn at a variable pace and are supported in their learning.
> - Effective learning resources are available any time and are reusable.
> - Assessments are secure and reliable."[22]

Schools looking to develop a competency based program, particularly one that will exist within the structures of a traditional, credit-based model, will do well to consider the principles presented above and develop the program in collaboration with university administration and registrar staff from the start. Additionally, a strong mentoring program to help students understand the competency structure and how to submit artifacts for assessment is critical to success.

Future Considerations

As we move forward with this new degree opportunity and admit additional cohorts of students, it will benefit the faculty fellows and the advancement of the degree to embed learning resources into the badges where students can access them consistently and when they are ready. In addition, we need to develop a structure for a robust mentoring program that can support more students with the same number of current faculty fellows.

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