Competency-Based Education in Science Teacher Education: The Next Disruptive Innovation or the Next Disruption?

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Introduction

Although competency-based education (CBE) is prominent mostly in medical and allied health, the scrutiny of colleges of education could have some looking for CBE as a solution to funding issues. As accreditation and ranking become increasingly more prominent and important in marketing education programs, CBE will likely be a focus for institutions. We looked into syllabi gathered from the Association and Science Teacher Education syllabus-sharing forum and cursory online searches for science teaching methods courses from over 100 institutions and aligned the most common topics with both Interstate Teacher Assessment and Support Consortium (InTASC) and National Science Teacher Association (NSTA) standards to see if common competencies in fact exist.

With more than 400 colleges and universities exploring CBE, mostly technology enabled, science teacher education is primed for joining this new paradigm. Budget models that rely heavily on student tuition drive some parts of this newfound interest, and career switchers who have worked outside of education in their respective discipline but decided to become science teachers with some practical life and job skills drive other parts of it. Those students generally want the path of least resistance to getting certified to teach so they can move into full time employment as quickly as possible. Couple this with the influx of first-generation college students who generally do not have the means to pay for a full degree while having states and banks continually limiting access to college tuition funds and the need for CBE becomes a conversation worth having in our profession. Just over 62% of college graduates are employed in positions that require a bachelor’s degree, while only 27% of college graduates worked in positions that corresponded to their undergraduate degree (Abel & Deitz, 2013). With that, how important are degrees to students? Are skills/competencies really what they desire now?

Detractors to CBE state that students will not experience the complete intellectual development that a traditional student might get at a college/university (Neem, 2013). Moreover, those pushing against CBE would say that students in CBE programs don't get the faculty face time that traditional students get, which also detracts from the quality of the experience for both teacher and student. Others would argue that CBE is solely workforce driven and thus lowers the quality of education (Prince, 2015). Many science teacher education programs are, in a sense, workforce driven anyway as programs are designed to teach and provide experiential platforms to students on pedagogical skills and classroom scenarios that make them classroom ready after a few courses.

In 2013, the United States Department of Education loosened the student aid rules to account for CBE. The new rules suggest allowing institutions to acquire student aid funding by creating programs that directly measure learning, not time, and where students can matriculate at their own pace. The USDOE calls this direct assessment. With diversity in mind, both age and race, colleges of education need to have foresight into current trends of university student populations and the alarming statistics that follow. According to Georgetown University's Center on Education and the Workforce, 82 percent of new white enrollments have gone to the 468 most selective colleges, while 72 percent of new Hispanic enrollment and 68 percent of new African-American enrollment have gone to the two-year and four-year open-access schools since 1995. The completion rates at the latter institutions are substantially lower: 49 percent for open-access two- and four-year colleges versus 82 percent for the most selective four-year colleges (Carnevale & Strohl, 2013). The National Center for Education Statistics projects that by 2020, 42 percent of all college students will be 25 years of age or older (Hussar & Bailey, 2012). Overall, not just in science education, only 11 percent of business leaders 'strongly agree' that students have the requisite skills for the workforce, whereas 96 percent of chief academic officers believe that their institutions are 'very effective' (56 percent) or 'somewhat effective' (40 percent) at preparing students for the work world (Jaschik, 2014).

While online learning has become more popular among both traditional and nontraditional students, we have reached the age of the *non-consumer* of high education. Nearly 71 percent of U.S. college-bound students do not participate in the residential college experience (Casselman, 2013). With the unanimous passing of the bipartisan Advancing Competency-Based Education Demonstration Project Act in 2014, the U.S. Department of Education announced that it was establishing experimental sites on college campuses for competency-based education (Ed Workforce, 2014).

The most prominent area in which competency-based instruction has been used is medical education. Competency-based Medical Education (CBME) requires instructors to assess students in a robust way that more accurately determines if they are prepared. The University of Toronto created a competency-based curriculum that provides challenge to medical residents by going beyond the core competencies. The developers of this program developed a curriculum that included forming a steering committee, faculty experts, and the accreditation framework. (Iglar et al., 2013). This model of CBME development could be applied to other medical schools and possibly other fields as well as this strategy grows and reaches more students.

Competency-based education has also become important to the field of nursing as the majority of employers expect that new nursing graduates are prepared to enter the field, perform various functions, and demonstrate that they have the required skills that are necessary for providing safe care to patients (Tilley, 2008). Unfortunately, there has been a concern by employers that new nursing graduates fail to demonstrate that they are competent in their abilities to perform basic clinical tasks or that there appears to be a disconnect between their education and work competencies (Tilley, 2008). Consequently, this leads to dissatisfied employers, discouraged new graduates, and disappointed patients (Anema & McCoy, 2010; Ruth-Sahd & Grab, 2012). A potential solution to this difficulty has been the implementation of competency-based education into the field of nursing education. Competency-based education has been used in the field of nursing in various ways. In the field of nursing, student performance evaluation has been conducted using the following scales:

- Schwirian's (1978) Six-Dimension Scale for Nurse Performance (6-D Scale)
- Nurse Competence Scale (NCS) (developed by Meretoja, Leino-Kilpi, and Kaira (2004)
- Self-Evaluated Core Competencies (SECC) Scale (Hsu & Hsieh, 2009)
- Competency Inventory of Nursing Students (CINS) (Hsu & Hsieh, 2013)

These quantitative instruments have shown to demonstrate strong validity and reliability for numerous studies (Klein & Fowles, 2009; Meretoja & Leino-Kilpi, 2001; Meretoja, Leino-Kilpi, & Kaira 2004).

One of the most important areas of competency-based education is developing milestones to describe the progression of competence. Iobst and Caverzagie (2013) discussed this process as called for by the Accreditation Council for Graduate Medical Education. They stated that "to be judged competent, the trainee must possess all the required abilities being assessed in a certain context at a defined stage of education or practice and must be able to apply those abilities appropriately in routine clinical practice." Defining competencies is the first step for any education program to create meaningful change in this area.

As with any growing area in education, there are some areas that CBE has challenges. One of these is that faculty may not be sufficiently prepared to assess new competencies. In any area where teaching methods are changing, such as medical education, it is imperative that faculty are provided with development around CBME and how to properly assess students (Holmboe et al., 2011). In a program at the University of Toronto faculty are required to build individual and system-based knowledge about competency-based education and ways how they should assess their learners using a new model of teaching and learning (Iglar et al. 2013).

Evaluation of Teacher Preparation Programs

According to Allen, Coble, and Crowe (2014), only one-third of teachers are being measured on their efficacy. The difficulties can be attributed to the lack of quality data in evaluating teacher preparation programs. Additionally, there is little agreement about the knowledge and skills that graduating teachers should possess and reveal through their work in the classroom. The issue that arises is the miniscule agreement on standards, competencies, and dispositions, which occurs at the abstract level that often times these skills are not able to be observed or measured via methods that present reliability and validity (Allen, Coble, & Crowe, 2014).

Council for the Accreditation for Educator Preparation (CAEP) and Pearson (Teacher Preparation Analytics (TPA) suggested that a report be devised that would review current available research and investigate available data from 15 states, as well as emphasize programs that showed to be successful at the national, state, and programmatic levels. CAEP and Pearson also requested a report that would display gaps in data collection and data systems with the goal of suggesting recommendations for improving data collection methods in order to obtain more valid and reliable data for evaluating teacher education programs.

However, the issue is that the CAEP and TPA presented an assessment measure for evaluating effectiveness of teacher programs themselves, rather than delving deeper into how current teacher preparation programs can be enhanced by incorporating various methods of instruction, such as competency-based instruction into their curriculum. In the Teacher Preparation Analytics report presented by Allen, Coble, and Crowe (2014), four key indicators are described that measure knowledge and skills of teachers after completing teacher preparation programs. The four indicators are as follows: teachers' academic content knowledge measured by college-level assessment, teacher's pedagogical content knowledge measured by national tests, teaching skills measured by national assessments, teacher's survey results where they rate the K-12 classroom teaching preparation program that they completed (Allen, Coble, & Crowe, 2014).

Teacher Education CBE

In science teacher education, we clearly have competencies; even if that is not what we call them. Common terms, such as personalized learning or adaptive learning environments have permeated throughout the science education literature. We should preface what follows with the importance of looking at CBE with a keen eye, but to not lose sight of the rigor of traditional teaching and learning. Competencies have a unique architecture as they break learning into discrete modules that are not inextricably tied to courses or topics. Time-based courses are the main currency in traditional higher education institutions, and in general, excising a week of learning from one class and inserting it into another course in an unrelated field is nearly impossible. In an online competency-based environment, however, all learning materials are tagged and mapped. Competencies are composed of series of learning objectives, and in many cases, students can draw on resources from various subject areas to achieve their learning objectives in order to master a competency. Because learning is not broken down by subject matter, an online competency-based education provider can easily combine and stack learning modules together in different ways for various students (Weise, 2014).

Cator, Schneider, and Vanderark (2014) argue that new times require new tools and new ways of thinking about teaching and learning. One vehicle for awarding competency is through badging. Cator, Schneider, and Vanderark suggest five distinct components to the badge earner process: 1. Issuer identifies and describes the competencies he/she desires. 2. Issuer established requirements for earning micro-credential/competency. 3. Earner produces and submits artifacts that demonstrates competency and meet the requirements defined by the issuer. 4. The submitted artifacts are assessed by experts or peers. 5. Credentials are awarded and shared.

Transitioning away from seat time, in favor of a structure that creates flexibility, allows students to progress as they demonstrate mastery of academic content; regardless of time, place, or pace of learning. CBE strategies could include online and blended learning, dual enrollment and early college high schools, project-based and community-based learning, and/or credit recovery, among others. It is contended that this type of learning leads to better student engagement because the content is relevant to each student and tailored to his or her unique needs. It can also lead to better student outcomes because the pace of learning is customized to each student.

CBE supporters suggest these strategies enable students to master skills at their own pace, help to save both time and money, create multiple pathways to graduation, make better use of technology, support new staffing patterns that utilize teacher skills and interests differently, take advantage of learning opportunities outside of school hours and walls, and help identify opportunities to target interventions to meet the specific learning needs of students. Each of these presents an opportunity to achieve greater efficiency and increase productivity.

Artifact Collection

The review of existing literature in the area of competency-based instruction led us to some questions for our own research:

1. What competencies are currently being evaluated in teacher education programs?
2. How do these competencies match up with the standards provided by InTASC and NSTA?
3. How could these areas of crossover be used to incorporate CBE into teacher education programs?

We set out to collect artifacts to answer these questions and concluded with consistency among science methods courses we looked into and were able to create a more involved study than we first thought possible. The methodology used to explore these questions was qualitative in nature and was a variation on a meta-analysis. Rather than looking at existing literature, we explored existing syllabi that are used in college and university science methods courses. To obtain these, we did an Internet search of science methods syllabi that were publicly available. We also went to the Association of Science Teacher Education (ASTE) syllabus sharing session during their conference in 2016. Through these two venues, we were able to find 178 syllabi. Of those 178, we then narrowed it down to 100, by making sure that we had a representation from large doctoral granting institutions, smaller regional universities, and some historically black colleges and universities. By doing this, we were able to make sure that our sample evenly represented all types of teacher education programs, but in reality, we could have used all 178 since we found that the majority had the same competencies. It is also important to illustrate that the syllabi chosen in this work were either the first methods course offered in a series or the only methods course offered in the science teacher preparation program. Of those syllabi that were the first in a series, we looked at the other syllabi available in the program and collapsed competencies to ensure the entire program was accounted for.

We went through the 100 syllabi and coded them for competencies that the courses mentioned the students should have after completing the science methods course. We were looking for commonalities in topics, readings, and content to see if our field is, in fact, already credentialing science teachers on common competencies. We then used our coding to come up with a condensed list of competencies taught in science education courses.

What are the competencies?

Through our exploration of the syllabi from teacher education courses at 100 different colleges and universities we found that the major topics each college or university covers during a science methods classes, elementary and secondary, are consistent in nine topics/ideas.

1. **Assessment:** assessment is discussed in terms of teachers developing different types of and how to assess students appropriately as a general, special needs, ELL or gifted student.

2. **Diverse Learners:** teaching to a variety of students in the classroom and being able to scaffold a lesson is being taught along with developing a lesson plan on implementation.

3. **Nature of Science/Inquiry:** this topic includes concepts such as what is science, what science should be taught, what are problems faced with teaching science and what misconceptions do students have about science concepts before new information is taught.

4. **Higher Thinking and Questioning of students:** The benefit and purpose to questioning students and developing an environment where students can feel comfortable to ask questions. This topic also includes students questioning each other in order to collaborate and work together for information and solutions.

5. **Lesson Plan Development/Inquiry/5E:** Teachers are asked to develop a science lesson that often involves inquiry and a hands-on activity. The 5E lesson plan model is widely accepted for professional lesson planning. Teachers are typically asked to submit several lesson plans throughout the methods courses. The lesson plans are geared towards scaffolding for all students, disabilities to gifted, and the lessons should encourage life-long learning

6. **Science and Literacy/Other Disciplines:** During lesson planning, incorporating other subjects is important to methods courses. The main focus for elementary science methods classes is literacy; however, many courses simply ask for a lesson to incorporate one other discipline

7. **Safe Science Classrooms:** Creating safety audits of classroom apparatuses (i.e., eye wash, fire extinguisher, signage, etc.) and identifying student safety issues.

8. **Classroom Management:** Creating classroom seating arrangements, teacher-student proximity, and discipline procedures.

9. **Understanding the Standards:** This seems to be individualized by state. There was not much evidence that NSES or NGSS were topics in this category.

What the standards say

If we map the common competencies mentioned previously to both the InTASC and NSTA preservice science teacher SPA standards, we begin to see gaps in our current science teaching method courses. With accrediting agencies and SPAs increasing pressures for national recognition, colleges and schools of education are wrought with faculty time away from what they were trained to do. Why did those nine competencies fall out of the 100 syllabi we examined if they don't align with accreditation standards?

InTASC

Taking into account the latest Interstate Teacher Assessment and Support Consortium (InTASC) standards movement toward learning progressions, we begin to see a flow of competencies deemed important for new teachers. The InTASC standards are:

Standard #1: *Learner Development*-The teacher understands how learners grow and develop, recognizing that patterns of learning and development vary individually within and across the cognitive, linguistic, social, emotional, and physical areas, and designs and implements developmentally appropriate and challenging learning experiences.

Standard #2: *Learning Differences*- The teacher uses understanding of individual differences and diverse cultures and communities to ensure inclusive learning environments that enable each learner to meet high standards.

Standard #3: *Learning Environments*- The teacher works with others to create environments that support individual and collaborative learning, and that encourage positive social interaction, active engagement in learning, and self-motivation.

Standard #4: *Content Knowledge*- The teacher understands the central concepts, tools of inquiry, and structures of the discipline(s) he or she teaches and creates learning experiences that make these aspects of the discipline accessible and meaningful for learners to assure mastery of the content.

Standard #5: *Application of Content*- The teacher understands how to connect concepts and use differing perspectives to engage learners in critical thinking, creativity, and collaborative problem solving related to authentic local and global issues.

Standard #6: *Assessment*- The teacher understands and uses multiple methods of assessment to engage learners in their own growth, to monitor learner progress, and to guide the teacher's and learner's decision making.

Standard #7: *Planning for Instruction*- The teacher plans instruction that supports every student in meeting rigorous learning goals by drawing upon knowledge of content areas, curriculum, cross-disciplinary skills, and pedagogy, as well as knowledge of learners and the community context.

Standard #8: *Instructional Strategies*- The teacher understands and uses a variety of instructional strategies to encourage learners to develop deep understanding of content areas and their connections, and to build skills to apply knowledge in meaningful ways.

Standard #9: *Professional Learning and Ethical Practice*- The teacher engages in ongoing professional learning and uses evidence to continually evaluate his/her practice, particularly the effects of his/her choices and actions on others (learners, families, other professionals, and the community), and adapts practice to meet the needs of each learner.

Standard #10: *Leadership and Collaboration*- The teacher seeks appropriate leadership roles and opportunities to take responsibility for student learning, to collaborate with learners, families, colleagues, other school professionals, and community members to ensure learner growth, and to advance the profession.

NSTA Preservice teacher SPA standards

Table 1 illustrates the map of the InTASC standards with the following National Science Teacher Association (NSTA) preservice teacher SPA Standards. We had the authors all prepare this alignment and then compared results while coming to agreement on where the competencies align to both InTASC and NSTA standards. For your references, the newest standards are:

Standard 1. *Content*. Teachers of science understand and can articulate the knowledge and practices of contemporary science. They can interrelate and interpret important concepts, ideas, and applications in their fields of licensure; and can conduct scientific investigations. To show that they are prepared in content, teachers of science must demonstrate that they:

(a) Understand and can successfully convey to students the major concepts, principles, theories, laws, and interrelationships of their fields of licensure and supporting fields as recommended by the National Science Teachers Association;

b) Understand and can successfully convey to students the unifying concepts of science delineated by the National Science Education Standards;

(c) Understand and can successfully convey to students important personal and technological applications of science in their fields of licensure;

(d) Understand research and can successfully design, conduct, report and evaluate investigations in science;

(e) Understand and can successfully use mathematics to process and report data, and solve problems, in their field(s) of licensure.

Standard 2. *Nature of Science*. Teachers of science engage students effectively in studies of the history, philosophy, and practice of science. They enable students to distinguish science from

nonscience, understand the evolution and practice of science as a human endeavor, and critically analyze assertions made in the name of science. To show they are prepared to teach the nature of science, teachers of science must demonstrate that they:

(a) Understand the historical and cultural development of science and the evolution of knowledge in their discipline;

(b) Understand the philosophical tenets, assumptions, goals, and values that distinguish science from technology and from other ways of knowing the world;

(c) Engage students successfully in studies of the nature of science including, when possible, the critical analysis of false or doubtful assertions made in the name of science.

Standard 3. *Inquiry*. Teachers of science engage students both in studies of various methods of scientific inquiry and in active learning through scientific inquiry. They encourage students, individually and collaboratively, to observe, ask questions, design inquiries, and collect and interpret data in order to develop concepts and relationships from empirical experiences. To show that they are prepared to teach through inquiry, teachers of science must demonstrate that they:

(a) Understand the processes, tenets, and assumptions of multiple methods of inquiry leading to scientific knowledge;

(b) Engage students successfully in developmentally appropriate inquiries that require them to develop concepts and relationships from their observations, data, and inferences in a scientific manner.

Standard 4. *Issues*. Teachers of science recognize that informed citizens must be prepared to make decisions and take action on contemporary science- and technology-related issues of interest to the general society. They require students to conduct inquiries into the factual basis of such issues and to assess possible actions and outcomes based upon their goals and values. To show that they are prepared to engage students in studies of issues related to science, teachers of science must demonstrate that they:

(a) Understand socially important issues related to science and technology in their field of licensure, as well as processes used to analyze and make decisions on such issues;

(b) Engage students successfully in the analysis of problems, including considerations of risks, costs, and benefits of alternative solutions; relating these to the knowledge, goals and values of the students.

Standard 5. *General Skills of Teaching*. Teachers of science create a community of diverse learners who construct meaning from their science experiences and possess a disposition for further exploration and learning. They use, and can justify, a variety of classroom arrangements, groupings, actions, strategies, and methodologies. To show that they are prepared to create a community of diverse learners, teachers of science must demonstrate that they:

(a) Vary their teaching actions, strategies, and methods to promote the development of multiple student skills and levels of understanding;

(b) Successfully promote the learning of science by students with different abilities, needs, interests, and backgrounds;

(c) Successfully organize and engage students in collaborative learning using different student group learning strategies;

(d) Successfully use technological tools, including but not limited to computer technology, to access resources, collect and process data, and facilitate the learning of science;

(e) Understand and build effectively upon the prior beliefs, knowledge, experiences, and interests of students;

(f) Create and maintain a psychologically and socially safe and supportive learning environment.

Standard 6. *Curriculum*. Teachers of science plan and implement an active, coherent, and effective curriculum that is consistent with the goals and recommendations of the National Science Education Standards. They begin with the end in mind and effectively incorporate contemporary practices and resources into their planning and teaching. To show that they are prepared to plan and implement an effective science curriculum, teachers of science must demonstrate that they:

(a) Understand the curricular recommendations of the National Science Education Standards, and can identify, access, and/or create resources and activities for science education that are consistent with the standards;

(b) Plan and implement internally consistent units of study that address the diverse goals of the National Science Education Standards and the needs and abilities of students.

Standard 7. *Science in the Community*. Teachers of science relate their discipline to their local and regional communities, involving stakeholders and using the individual, institutional, and natural resources of the community in their teaching. They actively engage students in science related studies or activities related to locally important issues. To show that they are prepared to relate science to the community, teachers of science must demonstrate that they:

(a) Identify ways to relate science to the community, involve stakeholders, and use community resources to promote the learning of science;

(b) Involve students successfully in activities that relate science to resources and stakeholders in the community or to the resolution of issues important to the community.

Standard 8. *Assessment*. Teachers of science construct and use effective assessment strategies to determine the backgrounds and achievements of learners and facilitate their intellectual, social, and personal development. They assess students fairly and equitably, and require that students engage in ongoing self-assessment. To show that they are prepared to use assessment effectively, teachers of science must demonstrate that they:

(a) Use multiple assessment tools and strategies to achieve important goals for instruction that are aligned with methods of instruction and the needs of students;

(b) Use the results of multiple assessments to guide and modify instruction, the classroom environment, or the assessment process;

(c) Use the results of assessments as vehicles for students to analyze their own learning, engaging students in reflective self-analysis of their own work.

Standard 9. *Safety and Welfare*. Teachers of science organize safe and effective learning environments that promote the success of students and the welfare of all living things. They require and promote knowledge and respect for safety, and oversee the welfare of all living things used in the classroom or found in the field. To show that they are prepared, teachers of science must demonstrate that they:

(a) Understand the legal and ethical responsibilities of science teachers for the welfare of their students, the proper treatment of animals, and the maintenance and disposal of materials.

(b) Know and practice safe and proper techniques for the preparation, storage, dispensing, supervision, and disposal of all materials used in science instruction;

(c) Know and follow emergency procedures, maintain safety equipment, and ensure safety procedures appropriate for the activities and the abilities of students;

(d) Treat all living organisms used in the classroom or found in the field in a safe, humane, and ethical manner and respect legal restrictions on their collection, keeping, and use.

Standard 10. *Professional Growth*. Teachers of science strive continuously to grow and change, personally and professionally, to meet the diverse needs of their students, school, community, and profession. They have a desire and disposition for growth and betterment. To show their disposition for growth, teachers of science must demonstrate that they:

(a) Engage actively and continuously in opportunities for professional learning and leadership that reach beyond minimum job requirements;

(b) Reflect constantly upon their teaching and identify ways and means through which they may grow professionally;

(c) Use information from students, supervisors, colleagues and others to improve their teaching and facilitate their professional growth;

(d) Interact effectively with colleagues, parents, and students; mentor new colleagues; and foster positive relationships with the community.

This map is subjective in nature and the nine competencies that fell out of our syllabi evaluation suggest there is not a clear alignment in standards to what the vast majority of the field is teaching in science teacher methods courses. It is interesting to note that an alignment with content knowledge did not show up in our syllabi, it might be because individual content areas at universities have their own standards and competencies that students have to meet usually before even entering a teacher prep program. Many science teacher education programs assume content knowledge before admission to their program. This was not always the case as we did find some syllabi that provided content-based courses in a pedagogical content knowledge setting but overall, it was not a common enough theme to fall out in our review.

Table 1. Map of InTASC, NSTA, and Common Competencies

InTASC Principles	NSTA Preservice SPA	Common Syllabi competencies
Standard 1 (Learner development)	Standard 5 (General Skills of Teaching), 10 (Professional Growth)	Diverse learners
Standard 2 (Learning differences)	Standard 5 (General Skills of Teaching), 6 (Curriculum)	Diverse learners
Standard 3 (Learning environments)	Standard 10 (Professional Growth)	Science & Literacy
Standard 4 (Content knowledge)	Standard 1 (Content)	
Standard 5 (Application of content)	Standard 2 (NOS), Standard 4 (Issues), Standard 5 (General Skills of Teaching)	NOS
Standard 6 (Assessment)	Standard 8 (Assessment)	Assessment
Standard 7 (Planning for instruction)	Standard 6 (Curriculum)	Management, Lesson planning
Standard 8 (Instructional strategies)	Standard 3 (Inquiry), 5 (General Skills of Teaching), Standard 7 (Science in the community)	Higher order thinking & Questioning, Lesson planning
Standard 9 (Professional learning and ethical practice)	Standard 9 (Safety & Welfare)	Safety, Understanding the standards
Standard 10 (Leadership & Collaboration)	Standard 7 (Science in the community), Standard 10 (Professional Growth)	Science & Literacy/Other disciplines

Implications

Although the push for CBE is arguably eminent, it does not come without its concerns and how it fits into the current budget and effort models in colleges and universities. For example, CBE doesn't fit the traditional semester model. If a student completes and shows competency on a given topic/theme, then that student is ready to move on to the next competency regardless of how long it takes him/her to show competence. Cohorts will be a thing of the past so admission, course scheduling, scope and sequence models will need to be revised. Colleges and universities need to change teaching load equations to fit competency experiences rather than full time equivalents (FTE). This has implications for retention, promotion, and tenure models.

In many degree programs, it is difficult to truly articulate what the degrees means and how that degree prepares students for the workforce. In science teacher education, our research base begins to tell programs what is important but relating that to practice is often the challenge. Along with standards and accrediting agencies, employer input is very important as we design competencies and the subsequent programs. Continual re-evaluation of the competencies and how we teach and assess said competencies is critical. Relationships with school systems is also very important to keep lines of communication open and an advisory panel that continually articulates what their needs might be to colleges and universities what school system needs.

Much of the CBE literature has a strong technology driven component to it. Programs that boast CBE success are technology driven and have a strong online presence. For example, UW Madison's 'flexible option' provides CBE degrees and has an average student age of 37.5. Assessment is crucial and with student working at their own pace, often working full time jobs, creating valid and reliable assessments might be more easily accomplished through technological means. Data management, enrollment, admissions, etc. are logistical concerns in CBE so technological solutions might be the most cost effective way to counter these issues. In the recent past Massive Open Online Courses (MOOCs) were to be the next great disruptive innovation in education. MOOCs promised to be the CBE vehicle of the 21st century but most would argue that MOOCS have failed and are clearly not the answer. The business model doesn't support them nor do the faculty or student completion and satisfaction models. The amalgam of workforce education, competency based learning, and online learning might be the secret sauce to reaching the non-consumers of higher education. The interesting, and maybe concerning irony is that technology integration into science teaching is not a competency that was common in the syllabi review. Maybe this is because teacher education programs rely on education technologies classes to cover that competency but it has been argued by many (Author, 2017) that discipline specific technology integration is most powerful.

Where do we go from here? It is our hope that this article begins the conversation in science teacher education that will propel our profession forward as CBE challenges come about. As we being this conversation, we can look to Cator, Schneider and Vander Ark (2014) suggestion on the four pillars of teacher professional development in a CBE environment:

1. Some element of teacher control over time, place, path, and/or pace
2. Balance between teacher-defined goals, goals as defined by administration through teacher evaluation efforts, and school and district educational goals
3. Job-embedded and meaningful integration into the classroom practice
4. Competency-based progression

Former U.S. Secretary of Education Arne Duncan said, "At a time when college matters more than ever, we have to provide **a flexible, innovative experience** that can meet the needs of every American." The time is now for science teacher education to look at the competencies we are all teaching, align them with the standards and principles of our accrediting agencies, and attract more students to work toward classroom ready skill sets in a time efficient and cost effective manner. Will this process be disruptive? Probably, but if it is a disruptive innovation than we have set up the next generation of science learners with teachers that are highly qualified and not in terrible debt.

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