Doctoral capstone seminar: Final integrative project

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This portfolio contains five artifacts created during the University of the Rockies Doctoral Capstone Seminar. The first artifact is a reflective essay that describes the coursework journey leading up to this capstone course. This artifact has two components; a reflective essay is in this portfolio and the accompanying presentation is hyperlinked to this portfolio. This presentation is rich with original work produced during the coursework for a PhD in Education with the concentration of Curriculum and Instruction, as conferred by the University of the Rockies. All of the original work mentioned in the presentation is hyperlinked and resides on the author's wordpress site. This portfolio also contains four research papers completed during the Capstone course. Each paper is presented independently with a subsequent reference section. This portfolio concludes with concluding comments that summarize the Capstone course and project, theories of particular impact to the author, the author's future professional plans and intentions for using this integrative final project.

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The PhD journey

The first component to this integrative project was a reflective presentation, in which I look at each course I took in sequence (Gaddis, 2016). The presentation includes reflective comments and many authentic artifacts of my work product during the course. I highlighted important work in each course, especially work that has a lasting impact on me and the communities in which I work and live. This reflective essay is the narrative for the presentation.

In *Learning and Cognition*, we surveyed the basic learning theories that we now know so well. I think cognitivism has the biggest impact on me. This is a diagram I drew as my daughter answered the question: “What is learning?” At the time, she had just completed the first grade. She said that learning was about putting information in the treasure chest, which is pretty insightful for a little one.

In *History of Education & Social Change*, we looked at the history of the American education system. This course presented a historical narrative that became the backdrop for countless writings throughout the program. The Harvard model promoted the higher education of the leadership elite. This goal has been steadily eroding as the need for a highly skilled workforce continues to be a pressing need in the country.

In *In-Residence Workshop 1*, the real ah-ha moment was pondering what it means to be a scholar-practitioner. I had never heard the term before. It is a salient description of my professional life and therefore I have used the concept to build confidence in myself and my goals. The traditional path to academia eluded me, but the scholar-practitioner model gives me a focus that fills the void of my intended steady rise in academia, rather than a decade of adjunct work, if it were not for my husband graduating from law school before me causing us to move away from my first graduate school, if it were not for my growing family, if it were not for my pressing need to contribute to the family income.

Educational Leadership Challenges & Opportunities was the first forward-looking course. It introduced several key literature pieces that are cited frequently in contemporary literature, and especially in papers that make a case for online education. These papers rely heavily on demographic statistics that reveal the ever-diversifying population of high education students in America, many of whom have many hats to wear like I do. Going to college is not their only pursuit and therefore the design of higher education has to diversify to accommodate this population who represent a signification portion of the skilled work force in America.

Diversity in Education was a real eye-opener. I learned that there are 40% more college students in America than when I was first in undergraduate school. I learned that there is no longer a white majority in America, especially when younger populations are measured. There are more non-white children than white children in American public schools and their progeny will tilt the demographic scales forever. Addressing this reality is probably one of the unique aspects of the University of the Rockies mission as compared to other institutions of higher education. We learned to appreciate diversity and cultural competence and this will be a very important job skill in American institutions. From institutional goals to course learning outcomes, multiculturalism foci need to be infused at every level. This diagram shows some of the way to accomplish this.

Research Design & Methods – Quantitative was a very important course for me. It afforded me the opportunity to forge a professional relationship with the Rocky Mountain Field Institute. I asked the Executive Director to review my final research proposal for the course, which we subsequently submitted as a grant application to both the Sigma Xi scientific research

Society and the Colorado Mountain College. We didn't get either grant, but it was extremely helpful to go through this process very early on in my dissertation musings. In this course, we also took a human subjects research training hosted by the National Institutes of Health.

Everything in *Research Design & Methods – Qualitative* was news to me. I have a masters in biology so I am pretty comfortable with quantitative methods. However, my knowledge of qualitative research was non-existent prior to taking this course. I liked that we had to conduct real interviews, which was very eye-opening as it revealed the kinds of scrupulous attention to detail needed in designing and preparing for qualitative research.

Assessment Research & Evaluation was not the most exciting topic in the program, but I assume it is quite important on a level I now appreciate, but have little interest in pursuing. I don't think coding interview data is a kind of tedium that I would relish. Nonetheless, I am fully aware that I might give up on the idea of tenure and end up working as an administrator, which will make this learning very useful.

Culture, Curriculum & Learning was a course in which I had the opportunity to research an institution for which I work. UCCS has an inclusiveness component in its mission, but the selective student admissions policies seem to be at odds with it.

Curriculum Development in an Adult Learning Environment was a fun class in which we wrote design worksheets. I love these kinds of writing projects because they allow me to write about something proximate to my professional life. In this course, I composed design worksheets for a lesson I regularly teach in my college biology courses. I also wrote a horticultural course design worksheet for a possible collaboration with the local at-risk high school. The Darwin's Finches activity was awarded a lesson of the week accolade and a national honorable mention in SoftChalk's yearly competition.

In-Residence Workshop 2 really emphasized the tenets of scholarly writing. I found this workshop to be rather boring, probably because I was already in graduate school and I am a published scientist already. Nonetheless, it was nice to interact with my peers and learn more about the resources available to UoR students.

My work for *Theories & Models of Instructional Systems Design* blossomed into a professional development webinar I gave to the CCCOnline faculty. This presentation provides a thorough compilation of literature and theories that drive modern education and subsequently, instructional design.

Curriculum, Assessment, Design & Evaluation brought up the themes of backwards design and learning outcomes again. In order to adequately serve a multicultural community, we need to embrace diversity through institution-wide and department-wide policy changes that facilitate cultural awareness in students' everyday lives at college. These shifts need to be central to the cultural experience of college, not tangential to it.

Likewise, the take-home message from *Integrating Technology* was emphasized with a backwards design approach. Technology literacy becomes a reality when course and institutional learning outcomes specifically address technology skills.

Strategies for Teaching & Learning was another course in which I got to work towards my dissertation concept by researching the Rocky Mountain Field Institute (RMFI). My term paper for this course described the citizen science program I intend to manage through RMFI. I used this paper as supporting evidence to persuade the Board of Directors. I presume the paper showed my dedication and forethought because the Board approved the program and also approved modest funding to support my time and methods.

In-Residence Workshop 3 was somewhat invigorating as it was our first time really talking about the dissertation process. We also dug into the literature. This presentation is interesting to review retrospectively. Even though it was only a few months ago, I feel like I have learned so much since then. It was a real pleasure to be with Dr. Stein again. This picture depicts her Venn Diagram concept, which promotes the idea that every dissertation topic has three over-arching literary foci. Identifying these foci facilitates effective literature use in any scholarly publication.

With a month to go before my baby was born, *Transformative Issues & Trends in Education* was not an example of my finest work and effort. Force Field Analysis was a core concept in this course, although I tended to disagree with this approach. This excerpt explains why.

Then right after my baby was born, I found myself in *Advanced Theories & Designs of Learning*. I worked on two design contracts this summer and therefore this course was extremely relevant to my professional career. In fact, I shared my paper with the instructional designer at CCCOnline with whom I was working and within a week's time, she asked if her superior could cite my work in a project he was working on for the entire Colorado Community College System.

Advanced Study in Mixed Research Methods was a somewhat sour note to end on as my professor kept insisting that I had no dissertation topic because the literature does not specifically call for assessment of training for citizen science research. I felt trapped in the course. I couldn't stop writing about mixed methods since the course was about mixed methods, but I did not want to continue on my trajectory since my professor seemed to undervalue the concept. After this experience, I feel fairly certain that my good *and done* dissertation will not involve mixed methods research. This is a surprising outcome since I had every intention of writing surveys that had both open and closed questions.

Finally, in capstone, we continued to reflect on this journey. This reflection comes at the end of this portfolio.

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Key challenges facing educational leaders

The key challenges in education today include the rising cost of higher education, the mounting debt assumed as a result, the diversification of the student population, and an increasing focus on quality, access, accountability, retention, legislation, and online education (Altbach, Gumport, & Berdahl, 2011). Putting specifics aside, the American higher education machine is a challenge in itself. Colleges and universities are gigantic organizations with hundreds of employees with almost as many job titles. Their budgets are complex and their academic programming, extracurricular activities, and student services are myriad. As a result, the qualities necessary for success as an academic leader are multifaceted and, in general, higher education leaders are scorned for their inefficacy (Bok, 2015). While there are countless challenges and opportunities in higher education to explore, this essay focuses on leadership and implementation of online education. Described herein are best practices for on-boarding distance education at a traditionally land-based university to ensure successful and sustainable programming. The leadership interventions described here are specific to the biology department at the University of Colorado at Colorado Springs (UCCS), a medium-sized, public, regional university.

Online programming is a disruptive innovation that challenges virtually every defining characteristic of traditional higher education. Online programming is nonetheless growing more aggressively than any other type of higher education (Allen & Seaman, 2013). The place-based culture of the historic American institution of higher education was thought to both enrich the mind and cultivate a cultural norm among the upper classes (Lucas, 2006). In the 20th century, the focus shifted to professional training and scientific discovery (Altbach et al., 2011). Now, in the 21st century, for the first time in history, “career preparation” supersedes “core academics” and "academic environment" as a driver for college enrollment (Eduventures, 2014). Online education serves this need for the growing student population without requiring geographic relocation or furlough from work. Furthermore, online education is more educationally accessible for more diverse students of an older age range and multiple learning styles as it departs from the traditional lecture format and instead provides a student-centered learning experience (Stravedes, 2011).

In the cycle of technology adoption, there are five characterizations of potential consumers (Moore, 2014). Institutions adopting online education in 2016 are the late majority. They are established institutions that were not the first institutions to follow the wave of online education implementation, but they are not laggards who hang back until the inevitable has consumed the entire educational market. UCCS, the institution of focus in this essay, is in this category. UCCS is slowly increasing its online course offerings. UCCS now offers six online undergraduate programs, six online graduate programs, and six graduate certificate programs ("UCCSConnect," n.d.). Biology is not one of these programs. Proliferating online programs at UCCS is a leadership opportunity.

While UCCS has a robust Faculty Resource Center (FRC) that offers training and funding for faculty who implement and/or teach online courses, the current challenge is one of consensus-building and professional community development. All programs offered by the FRC are voluntary and they stand alone beyond the scope of any particular disciplinary department. As such, participation in FRC programs is not part of departmental collegiality. The biology faculty feel as though online programming is being thrust upon them, handed down from the Associate Vice Chancellor for Online Education and Initiatives. They were not involved in any consensus-building process that brought online offering to the department. It is not possible to go back in time and change the course for the implementation period, but it is possible to open the lines of communication and create a culture of acceptance and academic quality surrounding online biology course offerings (Knight & Trowler, 2001). This will have a positive impact on student persistence and satisfaction (Kranzow, 2013).

The goals of this intervention are to increase awareness and acceptance of online biology education among the faculty. It might also have the added benefit of infusing technology and blended learning into the classroom-based courses in the department. Any increase in technology use and acceptance across the department would modernize the department's instructional practice. If successful, this intervention will improve the student experience and expand the educational opportunity afforded to students. It would also increase enrollments and revenue for the institution. All of these outcomes reflect a forward-thinking and competent leader (Black, 2015).

This intervention contains three components addressing leadership, faculty mentoring, and collegiality. The first component is to indoctrinate the Department Chair into the world of online education. The Vice Chancellor for Online Education should promote this through mentoring and interpersonal communication with the Biology Department Chair. Mentoring is an important component of leadership development in a technology-based society (Dziczkowski, 2013). By opening the lines of communication, the Vice Chancellor can find common ground upon which online programming in the biology department can be built. Bringing the Chair to a place of consensus and understanding will allow him to act as an effective champion for online education within the department.

In the cascading leadership schema, the Vice Chancellor for Online Education influences the Chair who influences the faculty. There is no one from the biology department who sits on the Teaching with Technology committee. The Chair should attend or invite another faculty member to join this campus-wide committee to engage a culture of technology in the department. When a new innovation is presented from an outsider perspective, it is more difficult to impart authentic experiences to one's community. Membership in the committee provides authentic social engagement and learning about how online education is implemented in other departments. The committee meets every other month and is attended by representatives from a variety of disciplinary departments. The attendees share technical and personal experiences related to online education. They collectively influence policies and procedures and reflexively report back to the Assistant Vice Chancellor of Online Education who dictates the patterns of online education at UCCS.

The biology department affiliate who attends these meetings should report back to the Chair (if not the Chair himself who attends) and also bring regular reports and information to the department meetings. This will provide a gradual education to the whole of the biology department by expanding the dialogue about online education. Effective communication and collegiality will result, allowing the department to feel as though their roles in the departments are relevant to the development of online programming and overall biology program improvements. An effective leader champions this communication and offers mentorship for those who want to take a more active role in online program development (Dziczkowski, 2013).

The primary concern for this collegial approach to leadership is that it dilutes the responsibility for successful implementation by spreading responsibility among a hierarchical schema of leaders (Knight & Trowler, 2001). Another critique is that it takes a longer period of time to enact (Knight & Trowler, 2001). Although noted, these concerns are somewhat dampened by the fact that at UCCS online education implementation is not a mandate of a transformational leadership approach; it is transactional in nature (Moman Basham, 2012). The Assistant Vice Chancellor has dictated that online education will occur and it is assumed that his role is prescribed with a top-down approach from the administration of the larger University of Colorado system. As such, this intervention is meant to ease the transition, but not to alter its course entirely. Positive leadership throughout the ranks can accomplish this with successful outcomes for both faculty and students alike.

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Implementing at-home experimentation for online collegiate science courses

Online education enrollments have soared since the 1990s (Allen & Seaman, 2013), but implementation of science courses has lagged behind non-lab courses in other disciplines. The laboratory component of science courses prevents widespread adoption of online science programming in higher education. This essay presents the key challenges facing at-home experimentation for online science courses. Strategies to overcome these challenges are important to the advancement of online science education and they are discussed here.

The laboratory component of science courses has not always been a leading phenomenon in science education, but now it is considered central to student engagement in science knowledge. The science laboratory in the science classroom is intended to elevate the rigor of learning to the level of professional scientific investigation (Handelsman et al., 2004). Experimentation increases students' practical and cognitive knowledge about a scientific discipline by providing a real-world application of learning (Kennepohl, 2007). Experimentation also promotes students' ability to manipulate and interpret numerical data and relate experimental measurement to scientific theory (Jeschofnig, 2004).

The specific outcomes of experimentation described in the preceding paragraph are evidence of constructivism through which students learn by experience. Constructivist principles are built on the assumption that students learn from new experiences by building upon their previous knowledge (Kruckeberg, 2006). Constructive learning involves problem solving, inquiry, and student-centered activities (Cramer, 2012). The age of constructivism has been followed by a well-spring of new science instruction models, including and most notably for science education, the 5E model of science instruction (Bybee et al., 2006). The leading at-home lab kit company, Hands On Labs builds all of their curricula using the 5E model for science instruction.

In the modern era, science educators are committed to laboratory experiences, but education is moving online. As a result, hands-on laboratory experiences need to occur at a distance. The first distance laboratory kit was used almost a half century ago in 1970 by the Open University (Jeschofnig, 2004). Despite this longevity in practice, resistance to the concept remains strong. This resistance grows from a lack of understanding about how it is possible that a student could have an authentic at-home laboratory experience. Nonetheless, authors indicate similar if not improved learning outcomes result when students use at-home experimentation kits (Durfee, Li, & Waletzko, 2004; Jeschofnig, 2004; Kennepohl, 2007). Furthermore, these authors describe at-home experimentation as a more student-directed and inquiry-based learning experience (Durfee, Li, & Waletzko, 2004; Jeschofnig, 2004; Kennepohl, 2007). This shows that at-home experimentation is well-aligned with the aforementioned constructivist premise for including laboratory experiences in science courses.

When students work alone, they have to take a leadership role working through the labs. They cannot rely on the impetus of their peers to complete an experiment. This makes each lab submission an authentic representation of the student’s aptitude with the materials. To ensure student identity in submission, students are required to take photos to self-identify (Figure 1). In contrast, in the lab classroom, on average, only one in four students is actually touching the manipulatives, for example, in a dissection (Gaddis, 2014). It is common for students to be able to complete the lab worksheet without touching anything, solving any problems, or discovering anything unexpected since the labs are presented in a procedural rather than inquiry-based fashion.

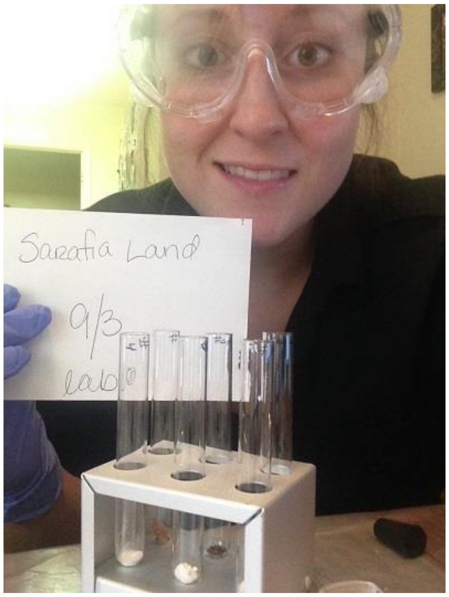

Figure 3. With each lab submission, a student submits a photo that includes her own face, an index card with her name and date, and some action of the lab. Here the test tube rack filled with each substance is shown.

Distance learning remains subordinate to traditional education because its inner workings are poorly understood by those who do not actively participate in them. Tenured faculty and seasoned administrators are involved in their traditional educational systems and have little reason to explore the efficacy of online education unless it is imposed upon them through new initiatives in an institution. Nonetheless, distance learning is growing immensely, with enrollment growth far in excess of traditional enrollments in the 21st century (Allen & Seaman, 2013). This growth does not necessarily imply a growth in quality education, but rather it implies growth in a new higher education sector.

The key to overcoming this quality misconception is the education of faculty and administrators who make choices about bringing science courses online. Higher education instruction is carried out increasingly by adjunct faculty who are paid on contracts to teach ("American Association of University Professors," n.d.). They have little job security and no research and publication component to their jobs. As a result, there is a paucity of peer-reviewed literature describing the phenomenon of distance science learning. There are third-party authors like Educause and the Online Learning Consortium, but the findings of these authors are suspect to the traditional mechanisms of American higher education because they tend to self-publish rather than publish through traditional peer-reviewed, scholarly journals.

The concept of peer-reviewed scholarly publication is a cornerstone of traditional higher education and a strength to retain in a new digital learning world (Cohen & Kisker, 2010). Using this traditional mechanism for disseminating research-based information about online science learning validates the findings. My specific recommendation is to promote more research and peer-reviewed publication to advance knowledge about at-home lab experimentation. This promotion must be supported by grant funding, including federal funds for scholarship and inquiry. However, much more funding is allocated to research than to education scholarship. For example, the National Science Foundation (NSF) offers grants in several categories including research and education, but the funding allocated to science education efforts is approximately one-fifth the quantity allotted to research (Figure 2). Furthermore, funding for research has increased dramatically in the past 10 years, but funding for education has slightly diminished (Figure 2).

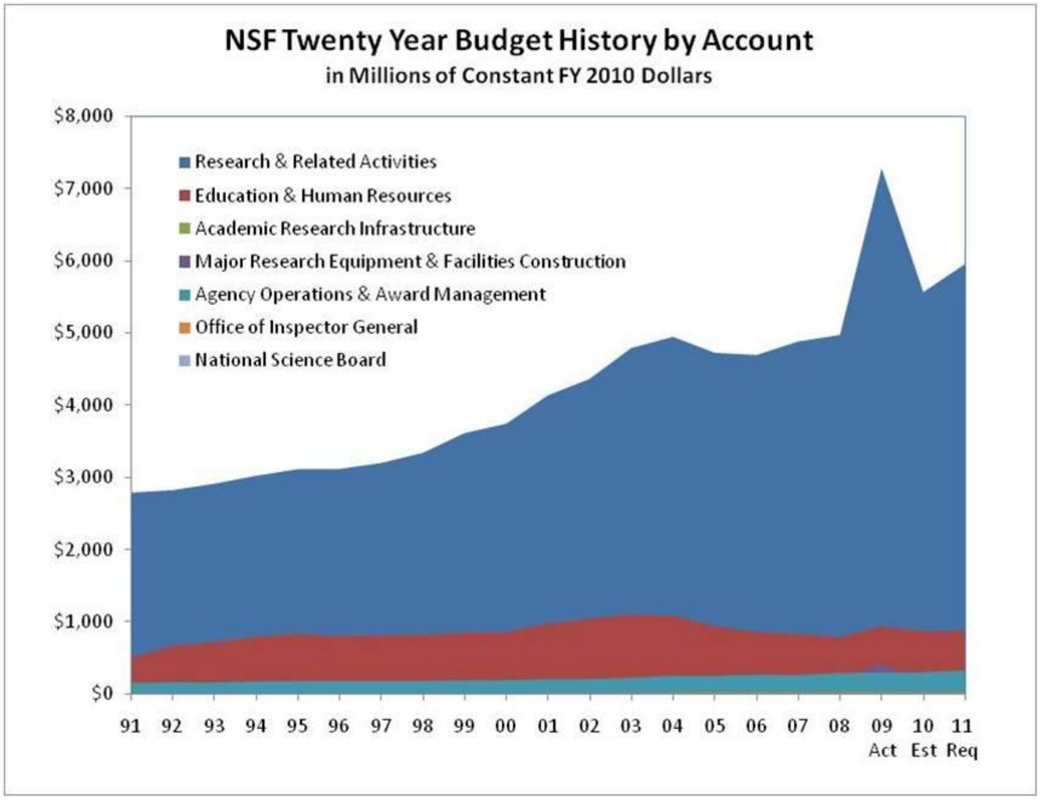

Figure 4. NSF funding has increased in the past two decades overall, but the margin afforded to research has increased dramatically while funding for education has decreased slightly (National Science Foundation [NSF], n.d.).

Increasing scholarship in the realm of at-home experimentation to accompany online science courses could be promoted with novel employment structures for contingent faculty, or perhaps through a reduction in contingent faculty proportions relative to full-time faculty. If the United States is serious about improving higher education, the educators who drive the student experience would be afforded living wages and opportunities to pursue the full gamut of scholarly behaviors associated with academia including independent inquiry, research, and publication. It is clear to those who enact online education that at-home experimentation is a valid and effective educational tool, but no one else is going to know this and champion it if there is little peer-reviewed literature to drive it forward in academia.

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At-home science experimentation for online science courses: A program evaluation proposal

Online science education is challenged by the implementation of distance science laboratory experiences. At-home science laboratory kits have been used for almost a half century to facilitate online science learning (Jeschofnig, 2004). Nonetheless, their existence is not well known and understood. Some apprehensive parties assume that the laboratory component is also online just as the lecture component of a course is administered at a distance through a learning management system (LMS). This assumption is unfortunate because at-home experimentation is a hands-on, authentic, and effective means of delivering the laboratory component of an online science course (Durfee, Li, & Waletzko, 2004; Jeschofnig, 2004; Kennepohl, 2007). To evaluate this premise, and to understand if online lab science courses promote the strategic objectives of the Colorado Mountain College (CMC), this essay presents a proposal for program evaluation.

Colorado Mountain College is a rural, in-district community college system with 11 campuses in the intermountain region of Colorado spanning 12,000 square miles and serving over 20,000 students ("FAQ," 2016). CMC ranks in the top 13% of community colleges in the U.S. CMC offers fives bachelor’s degrees, which have been recognized as the third most affordable bachelor degrees in the U.S. CMC is supported by property taxes and governed by a Board of Trustees and is accredited by the Higher Learning Commission ("CMC Snapshot," 2016). Over 20% of CMC students are non-white, 17% of whom are Hispanic students ("FAQ," 2016).

The strategic plan for Colorado Mountain College includes five goals: student success, teaching and learning, access, community and economic development, and organizational effectiveness (Colorado Mountain College [CMC], 2014). This proposal will evaluate two of these goals, student success and teaching and learning. CMC will promote student success with appropriate student support services that accommodate the needs of these students. CMC will “provide excellent learning opportunities,” by “improving the quality of existing educational offerings” (CMC, 2014). Online sciences courses are one way in which the institution expands access to collegiate education for students in the service area. Many science courses are guaranteed to transfer (GT courses), which means a student taking a GT course anywhere in Colorado can transfer it to any other two- or four-year institution in Colorado without exception. As such, GT courses must confer a general student competency for transfer. Additionally, GT courses offered at CMC are of equal opportunity value as the same courses offered at more expensive institutions, but they cost much less. This is an important value proposition for prospective and current students at CMC.

The program evaluation model employed in this proposal is an objectives-oriented approach ("University of North Carolina at Greensboro," 2013). The early work of R.W. Tyler set the stage for objectives-oriented evaluation and influenced future educational legislation including the Elementary and Secondary Education Act of 1965, which was the first educational legislation in America to require evaluation of educational programs (Finder, 2004). The Tylerian Era (1930-1945) was defined by the Eight-Year Study in which Tyler evaluated the outcomes of 30 high school programs (Hogan, 2007). This seminal study set the stage for a phenomenon educators now call backwards design (Wiggins & Mctighe, 2005), a predominant course design process in which the definition of learning outcomes drives a course design process. The determination of objectives for a program is an inherently value driven process (Tyler, 2013). The values inherent to the concept of a science lab to accompany the lecture component of a course are related to the inquiry-based nature of scientific investigation (Jeschofnig, 2004; Kennepohl, 2007).

In light of the current political emphasis on accountability in American education, an objectives-based approach is an appropriate evaluation schema because it produces measurable outcomes with which legislators, school officials, educators, and consumers of the educational system, including students, parents and employers, can make decisions. The proposed program evaluation is a formal one in which systematic measurements produce quantitative results (Stufflebeam, 2001). It is formative in nature as the primary intention is to influence program improvement while also measuring program effectiveness (Welch, 2011). This kind of program evaluation is used by primary stakeholders including students, faculty, and higher education administrators (Welch, 2011). It is likely that the results of this program evaluation will be informative to policymakers and external auditors like regional accreditors as well. However, the primary intention of this program evaluation is to validate alignment between the use of distance science lab kits for online science courses and the strategic goals of CMC. Since the use of distance science lab kits is broader than its application at CMC, it is likely that this program evaluation will serve as a case study that can be extrapolated to other institutions of higher education interested in validating the use of distance science lab kits for their online science courses.

The proposed program evaluation will involve a comparative analysis of learning outcomes and student achievement between cohorts of students taking traditional science labs and those taking online science courses with distance science lab kits. A curricular analysis will begin the process. This will involve identifying all the GT science courses offered at CMC as both residential and online courses. The paired courses will then be compared for course design features, including predominant learning theory applications, labs employed, and assessment strategies. If paired courses are widely divergent, a tangential effort will ensue to standardize the course offerings to increase reliability in the data collected. It is likely that this will be a necessary step, however this is not known at this time, as the *a priori* research of comparing courses has not already occurred.

Once the paired courses are selected, students in these classes will take a pre-test to assess their knowledge of the lab course learning outcomes prior to entering the course. Students will complete the course and then take a post-test to assess their knowledge gain. The success of paired groups will be analyzed. Students in this experimental cohort will be followed by a longitudinal investigation to assess their future success in science courses that employ the knowledge gained in the paired courses in this investigation. The longitudinal investigation will also track the academic progress of these students, measuring their degree attainment and passage into a four-year institution of higher education. The longitudinal investigation will focus on those students who self-identify in the pre- and post-tests as science majors. While the learning outcomes of non-major students are of interest in the primary program evaluation, it is likely that these students will not have a requirement to take additional science courses and therefore they will not be a source of continued data.

This proposed program evaluation will either validate the use of distance science lab kits or call into question this educational practice. If the latter results, the online learning campus of CMC may re-evaluate the effectiveness online science courses as this relates to the strategic goals of the institution. Expanding access by offering online science courses may not improve student success and/or the quality of educational programming offered. If so, the misalignment of objectives will need to be addressed by the institution. Of particular concern will be the statewide articulation for GT courses. If the evaluation reveals that distance science lab kits do not promote the same learning outcomes as traditional face-to-face lab offerings, the GT endorsement will be jeopardized.

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At-home lab kits for online science courses: Research methods

Collegiate science courses typically have a lab component. The lab is considered an essential component of hands on, student-centered learning in science (Jeschofnig, 2004; Kennepohl, 2007). It provides experience that is analogous to the real scientific practice of professionals, which affords students practical and procedural knowledge for pursuing careers in science. When sciences courses are brought online, there are several ways to meet the lab component including virtual labs, weekend lab camps, instructor-supplied materials, and at-home lab kits (Carrigan, 2012). At Colorado Mountain College, a state community college system in Colorado, at-home lab kits are used. This research investigates at-home lab kits used to provide the laboratory experience for a college-level online science course. Similar research conducted five years ago began the data collection process for these research questions:

1. Do students using at-home lab kits and students in the traditional lab achieve similar or dissimilar results when the same assessment is offered to both groups? Which group has higher achievement?
2. What motivates students to take online lab courses? Do they prefer the experience online or is it a matter of convenience, or other circumstance?
3. If students in these comparative groups are science majors, is their future science degree attainment the same or different?

After five years of program implementation, it is time to check back in with these students with regard to the third research question. The present study will assess the degree progress and attainment of these students, herein referred to as *2011 subjects*. In addition, a new cohort of respondents will be engaged and measured. The new cohort, herein referred to as *2016 subjects* will be administered the same assessment and survey used in the 2011 study. These data will be compared with the 2011 assessment and survey data collected. The data collected in this study include quantitative assessment data, qualitative and quantitative survey data, and quantitative registrar data. This mixed methods design affords insight into the statistical differences, if any, between groups. It also provides analytical information about how students feel about taking lab science courses online or in the classroom over time.

At-home lab kits have been used at Colorado Mountain College (CMC) for two decades. A professor there, Dr. Jeschofnig, made his own kits and sent them to his students who had difficulty being in class with regularity due to the geographic position and climate of the Leadville campus of CMC (Jeschofnig, 2004). Leadville is the highest incorporated town in the United States, situated above 10,000 feet in the Colorado Rocky Mountains. What started as a single professor trying to provide more educational continuity for his own students has now grown into a Fortune 500 company called Hands On Labs. The company supplies lab kits to hundreds of institutions around the globe (Hands On Labs, 2016).

In addition to Hands On Labs, a few other companies and organizations supply distance lab kits to institutions of higher education, including E-Science (eScience Labs, 2014), and Thompson Rivers University (Brewer, Cinel, Harrison, & Mohr, 2013). Indeed, the phenomenon of distance lab kits dates back at least a half century (Jeschofnig, 2004). Despite this long-standing use, there is still a bias against distance lab kit use. While the at-home kit fosters student independence, critical thinking, and economic relief (Carrigan, 2012), the rigor of at-home lab kits is questioned (Newman, 2011). This research investigates the educational validity of at-home science lab kits by providing a direct comparison between student outcomes using the lab kits in conjunction with online science courses and student outcomes using traditional lab experiences on campus.

In this mixed methods survey study, a pairwise sampling design (Onwuegbuzie & Collins, 2007) compares students in the same science course administered online or on campus with an accompanying at-home lab kit or campus-based lab respectively. Some hybrid courses combine these conditions by either offering the distance lab and campus-based lecture, or vice versa. These combinations are not explored in this design, but they could be considered in a future investigation.

The qualitative and quantitative components of this study occur concurrently (Greene, 2007). Random sampling is rare for both qualitative and quantitative studies (Onwuegbuzie & Collins, 2007). A purposive sample of all students taking a Common Course Numbering System (CCNS) science course that is offered both online and on campus at CMC will be selected. The course designs are variable as professors are allowed to design their own online courses at CMC. Only paired courses in which faculty agree to administer the same lab tests will be included in the study. All students in these courses will be asked to sign an informed consent to participate in the study. If students choose not to sign the informed consent, their data will not be included in the analysis.

The degree attainment information of the 2011 subjects will be collected from the registrar. The assessment data of the 2016 subjects will be collected from the Learning Management System (LMS). The survey questions administered to the 2016 subjects will be investigated with a mixed methods survey that contains both quantitative questions and qualitative questions. The quantitative survey data collected will include demographic information about each student specifically related to their major, degree progress, and academic and career aspirations. The qualitative survey data collected will include open-ended responses in which students describe their motivations and preferences for taking a science course online or in the classroom.

The degree attainment data of the 2011 subjects and the quantitative survey data of the 2016 subjects will be analyzed with descriptive statistics. The means between the groups will be analyzed with a t-test to determine if there is a statistically significant difference between them. The assessment data between groups of 2011 subjects and between 2011 subjects and 2016 subjects will also be analyzed with descriptive statistics and a t-test. The qualitative survey data will be descriptive in nature, but employ no statistics (The Research Methods Knowledge Base, 2006). The responses to these open-ended questions will be used to describe the student identity. Software such as NVIVO ("NVIVO," n.d.) has the capability of analyzing word usage and frequency. Depending on the ultimate sample size measured, this kind of analytical approach could make more efficient use of the researcher’s time and provide compelling information about student motivations and preferences.

Each course has no more than 24 students so each paired course grouping would have a maximum of 24 students per group. If every student within the paired course groupings agrees to participate by signing the informed consent, the measurement would not be of a sample per say. The entire population would be measured. However, on a greater perspective of scale, one course is a sample of all the courses offered that meet the parameters of the courses used in this study. The appropriate sample size from this larger perspective depends on the total population size, ie the number of courses and students taking online lab science courses at institutions that also offer the course on campus. This population size is not known at this time.

This causal-comparative research method (Curry, 2016) seeks to draw connections between student assessment scores and lab delivery. These connections are correlations at best, but not rigorous enough to determine causation. The primary issue that arises in this particular study is the variability in course designs and deliveries. The conditions required to isolate all variables except for the lab delivery method are impossible to achieve. They would require the same professor teaching the same exact course online and in the lab to the same group of students. The only approximation of this reality would be a course that mixed both campus-based and online labs, but then the lab itself would be the interfering variability. If just one lab was administered both ways to the same students, then temporal sequence would confound the results. With this in mind, descriptive statistics are the most powerful analytical tool suitable to this design (Curry, 2016). Actual correlation analyses are not appropriate because they require variables measured in at least intervals, however these data are categorical, not continuous data (The Research Methods Knowledge Base, 2006).

No ethical concerns arise with this research. No children or sensitive groups will be studied, and no experimental conditions exist. While this research focuses on the comparison between the specific achievements of CMC students using lab kits and those working in a traditional land-based lab and lecture course, the meta-inferences of this research are potentially broad (Tashakkori & Teddlie, 2003c). These data and results could reinforce the presence of at-home lab kit courses at institutions of higher education across the country, or it could create a reason for re-evaluating. Whether or not the assessment data and degree data suggested that at-home lab kits are a strength to retain, the qualitative data collected will provide a rich description of who takes science courses and/or online science courses, and why they do it.

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Concluding Comments

This course was an informative and affirming end to a journey that hasn't seemed too arduous. Although the pressures of work and family were ever-present, I never felt like this journey was a burden not worth taking. "Doing my homework" has been an intense labor, but the outcomes are positive. I wrote close to 100 papers, not including discussion posts that turned out to be papers in their length and research effort. I remember reading Outliers: The story of success by Malcolm Gladwell in which he puts temporal analysis to the test of several examples. He states that it takes 10,000 hours to become an expert at something (Gladwell, 2008). This equates to approximately 20 hours per week for 10 years.

While I have only been writing papers for 20 hours per week for two years, I feel a lot closer to that position of expertise. I feel closer to being a scholar who creates knowledge for all of mankind. I think the most important outcome is one of self-confidence. I knew how to write before, but now I feel that I know more about American education than most people and that I am in a position of authority. Of course, my writing has also improved, but my attitude is what really needed an adjustment. I never feel fully adequate in my position as a biology instructor, primarily because I do not have many opportunities to teach exactly what I know, which is ecology. With regard to education, I feel confident that my knowledge is now wide and well developed.

This capstone course has been helpful in promoting deep knowledge attainment. In these final strides, I am no longer chained to the article search. I can recall theories and authors without looking them up. I can recall concepts of importance to my philosophy without having to think about why I think they are important. Thinking back to one of my first courses in which I drew a picture of a treasure chest that my daughter described when I asked her what learning was, this capstone course helped to push knowledge in my working memory into the treasure chest. Concepts of cognitivism have had the greatest impact on me. Training the mind is a process of discipline and metacognitive awareness (Bruner, 1957; Pederson & Liu, 2002). One needs to think about how to learn while also attempting to process the new knowledge. Layering these skills together has been the single greatest improvement in my instructional practice arising from this PhD journey.

Even before my role as an educator in higher education, I was a volunteer and employee of non-profit organizations that provide learning for children in the realm of outdoor, environmental, and ecological education. The idea that learning is experiential is a given when teaching out-of-doors. It is my passion. Prior to this journey, I had no tools to explain why it works. Learning about constructivism (Vygotsky, 1962) and relevant hands on, experiential and project-based learning concepts (Bybee, 2009; Kolb, 2015; Reid, Williams, & Paine, 2011) has afforded me the vocabulary and knowledge to not only enact skillfully this kind of learning experience, but to also defend its efficacy to others.

The final project for the capstone course provided professional skill development. I had never before attempted to format a paper with chapters according to American Psychological Association (APA) guidelines. I also had never taken the time to produce a portfolio worthy of use for employment acquisition. As I noted several times in the course summary project, which was the first part of this integrative project, I appreciate the opportunities that provide direct connections between my academic and professional lives. I intend to use this portfolio in future employment applications. Of great importance to me was the compilation of my best papers that came through the course summary project. Although this was not required for the capstone integrative project, it is extremely important to me to reflect on these papers because I intend to publish several of them. This voluntary effort on my part advances the likelihood that I will attend to publishing minor works before finishing my dissertation in the next nine months.

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