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Editor’s Column

Dear Readers,

This is the ninth issue of the ***Journal of Research in Innovative Teaching*** (JRIT), published by National University annually since 2008. It demonstrates steady progress in establishing a research culture at this institution, where the journal plays an important role.

National University’s mission is to provide exceptional learning experiences to our students by offering lifelong learning opportunities which are accessible, challenging, and relevant to a diverse population and the demands of the 21st century. In line with this mission, the annual publication of National University’s research journal is an important benchmark in the university’s maturity progression. Teaching, research, and scholarship are interrelated; evidence shows that research—particularly scholarship of teaching and learning—enriches teaching and is capable of significantly improving the quality of education. Therefore research culture is one of the essential parts of the general university’s culture.

The JRIT is an annual, multidisciplinary peer-reviewed publication of original research focused on new effective instructional approaches, methods, and tools. It is intended to produce momentum in our quest for excellence, to increase the efficiency of research, scholarship and learning, and to ensure better learning outcomes for our students. The journal is a forum for sharing faculty accomplishments in this area, which will ultimately benefit both the university’s academic community and our students. The editorial board is composed of top scholars and administrators from National University, as well as nationally and internationally acclaimed scientists. The review board includes both internal and external reviewers.

This issue features nine articles accepted after a rigorous, double, blind peer review. Among the authors you will find National University faculty members, outside scholars working with the university researchers, and U.S. academics from outside the university.

Each article in this issue has been assigned to one of the following sections:

- Higher Education
- Teacher Education
- Subject-Specific Teaching and learning

In the **Higher Education** section, the article by Amber W. Lo, Jodi Reeves, Paul Jenkins, and Russell Parkman, *Retention Initiatives for Working Adult Students in Accelerated Programs* examines the applicability of Tinto’s Institutional Action Model to AL students who are both full-time workers and parents. Empirical data were collected from surveys and analyzed statistically. Overall, most of the recommended initiatives from the Institutional Action Model are positively perceived by these students. Institutions that target working adult students can use the results of this research to fine-tune student retention initiatives in their AL programs. This research helps to better understand student retention in accelerated learning programs.

The **Teacher Education** section opens with the article *Purposeful Use of 21st Century Skills in Higher Education* by Ron Germaine, Jan Richards, Marilyn Koeller, and Cynthia Schubert-Irastorza. The authors posit that the term 21st century skills is an overarching expression for the knowledge, skills, and dispositions seen as prerequisites for success in the global workplace of the future. The purpose of their article is to describe the context and definition of 21st century skills, and to illustrate how each skill may be purposefully integrated into post-secondary teaching.

The article by Maureen Spelman, David Bell, Earl Thomas, and Jennifer Briody *Combining Professional Development & Instructional Coaching to Transform the Classroom Environment in PreK–3 Classrooms* presents a 2-year study which examined the impact of mathematics-focused professional development and instructional coaching support on classroom quality in five inner-city Catholic elementary schools. The results demonstrated that in two major domains there was a noted increase in classroom quality when comparing pre- and post-data. The domain of classroom organization demonstrated significant improvement with instructional support also demonstrating positive gains. The domain of emotional support did not demonstrate significant improvement when comparing pre- and post-data results.

In the article *Putting the Pieces Together*: *A Model K–12 Teachers' Educational Innovation Implementation Behaviors*, Louis S. Nadelson and Anne L. Seifert discuss K–12 teacher engagement with educational innovation behavioral elements. As part of a week-long science, technology, engineering, and mathematics (STEM) education ? they developed a professional development program involving over 600 teachers in year six of implementation, gathered pre and post data, and aligned it with educators' consideration of innovative STEM education initiatives, including perceptions of teaching core STEM practices and 21st century skills. Significant correlations among multiple measures motivated the creation of a structural equation model using comfort teaching STEM as a proxy for propensity to implement educational innovations. This equation was transformed into a model of teacher behaviors associated with implementing educational innovation

Robyn A. Hill presents the article *Real World Connections: A Case for Integrating Environmental Education into Preservice Teacher Education* where she argues for improving environmental literacy which is imperative to the wellbeing of children and the planet. This paper makes the case for fully integrating environmental education into preservice teacher education, rather than relegating it to the purview of teacher, school, or district initiatives or to community-based partnerships that may not be able to provide a cohesive and comprehensive approach to the content.

In her article *The Flipped Classroom in a Hybrid Teacher Education Course: Teachers' Self-Efficacy and Instructors' Practices*, Patricia Dickenson states that the hybrid course format provides the means for self-directed asynchronous activities like the flipped classroom to take place in a virtual space, which can free up valuable face-to-face class time. A case study she describes involved a comparison of two hybrid teacher education classes: one using traditional lecture during face-to-face meetings, and the other providing video lecture. Measures of candidates' confidence towards teaching were compared through self-assessment. Results found statistically significant differences in confidence gains when participants experienced the flipped classroom.

The **Subject-Specific Teaching and Learning** section features three articles. Ronald P. Uhlig and Kamlesh T. Mehta write that not enough students are signing up for computer science degrees to close the gap between job openings and applicants. In their paper *Computer Science Graduates: Teaching Innovations, Earnings, and Reducing the Shortfall* they discuss (a) the process of choosing a career, (b) innovations that have been introduced into teaching to overcome student reluctance to pursue a "difficult" degree, and (c) three influences on career choice. Job security and job satisfaction of computer science graduates are analyzed. The impact of computer science degrees on income is considered. The results show that National

University's focus on working adults and accelerated learning is helping to reduce the shortfall in the number of US computer science graduates.

In *Course Redesign of Online Non-Majors Biology: Analysis of Effects* Ana Maria Barral, Rachel Simmons and Denise Tolbert discuss an online non-majors General Biology course (Survey to Biosciences, BIO100) they redesigned by implementing a number of Constructivist and active learning approaches, and selecting a new textbook. Thirty courses before and thirty courses after the redesign were analyzed for student survey results, BIO100 and the corresponding Survey to Biosciences Laboratory (BIO100A) course grades, as well as the influence of student demographics such as age and ethnicity. Official end-of-class survey scores of student perceptions of teaching, learning, and course content were compared pre- and post-redesign. They present their findings.

Finally, in the article *Mobilizing the Newsroom in an Online Class: How Master's Journalism Students Capture, Edit, and Publish the News,* Sara-Ellen Amster, Scott Campbell and Cynthia Sistek-Chandler argue that mobile technologies are changing the way university students interact with online course content. In a pilot program at one institution, digital journalism students worked with an iPad Mini 3 (iPM3) to capture, edit, and publish the news. Nine students in this qualitative research study reported an ease of use greater than in previous field experiences of news reporting. The data showed this was due to three main attributes: mobility, portability and the compact nature of the device; speed at which the device was adopted, (adoption of innovation); and immediacy, the ability for the student to quickly perform news functions.

Note to the Author offers guidelines for authors submitting their papers to the Journal of Research in Innovative Teaching.

We invite scholars to submit their research for the tenth issue, to be published in 2017.

Peter Serdyukov
March 1, 2016

Higher Education

Retention Initiatives for Working Adult Students in Accelerated Programs

Amber W. Lo
Jodi Reeves
Paul Jenkins
Russell Parkman

Abstract
With the increasing availability of higher education programs in an accelerated learning (AL) format, student retention in AL programs has emerged as a topic that needs to be better understood. This study investigated the applicability of Tinto's Institutional Action Model to AL students who are both full-time workers and parents. Empirical data were collected from surveys and analyzed statistically. Overall, most of the recommended initiatives from the Institutional Action Model are positively perceived by these students. Institutions that target working adult students can use the results of this research to fine-tune student retention initiatives in their AL programs.

Key Words
Accelerated learning (AL), student retention, retention initiatives

Introduction

Student retention is an important issue in higher education. Among students who took the ACT college readiness assessment between 2006 and 2012, the first-year dropout rate of those who entered a four-year college was about 12% in 2006 and the same in 2012 (Buddin, 2014). *Retention* is the rate at which a higher education institution retains and graduates students who first enter the institution to work toward a credential, such as an undergraduate or graduate degree (Tinto, 2012b). Such a student may transfer to this institution with a part of the credential requirements fulfilled or may start from the beginning of the program. Tinto (2012a) believed that research should focus on implementable and effective retention policies and initiatives that educational institutions can adopt to enhance student retention rates. Tinto proposed the Institutional Action Model (IAM) and recommended several general retention initiatives (or "programs") based on actions that are relatively under the control of the higher education institution.

Accelerated learning (AL) is a form of college education that enables students to achieve a desired set of learning outcomes in a shorter period of time in comparison to the conventional learning format (Serdyukov, 2008; Tatum, 2010). The total number of contact hours in an AL course is the same as that of the conventional format, but the total duration of an AL course is shorter (4 to 6 weeks as opposed to 15 to 16 weeks in a semester). In an AL course, the material is taught in longer or more frequent sessions. While the topic of student retention has been studied for decades, the retention of higher education students enrolled in AL programs is a relatively new topic. Further, in universities that offer AL programs, the student demographic is different, and includes a large majority of adult students who have to balance work, family, and school.

This study investigated the applicability of the IAM to AL students who work full time and also have dependents. The objective was to determine which retention initiatives are suitable for them.

Accelerated Learning Programs (Onsite and Online)

To date, few studies have focused on students enrolled in AL academic programs. Usually (but not necessarily), students in AL programs share many characteristics with non-traditional undergraduate students, though many are graduate students. In AL, courses are compressed and intensive (Serdyukov, 2008; Tatum, 2010). Students are expected to be highly motivated and to study independently. Time pressure is inevitable. Since the AL format is gaining popularity among higher education institutions, administrators and faculty in higher education need to understand the persistence factors that are specific to this format, so that proper institutional policies and initiatives can be implemented to enhance student retention in this environment.

Some AL programs remain onsite with a fixed schedule of class meeting times for face-to-face class sessions in a physical classroom. In the AL format, because the total length of time for a course is compressed, the length of each class period is usually much longer than the usual 50-minute or 75-minute class period in traditional university courses. AL courses can be delivered onsite or online. An onsite program is an academic program in which each of its courses is conducted face to face in a physical classroom where the instructor and students are physically present. An online program is an academic program in which each of its courses is conducted online via an electronic learning management system (LMS). In addition, many such online courses also have a virtual classroom in which an instructor can conduct synchronous and recorded lecture sessions. This virtual classroom performs the same function as a gathering place for the instructor and students to be present at the same time. Conducting such synchronous class sessions is not a necessary condition of an online course. Some AL programs are in a hybrid format: partly face to face and partly online.

The Institutional Action Model

The Institutional Action Model (IAM) was proposed to analyze student success using factors outside the control of the institution and factors within the control of the institution (Tinto, 2012a). Persistence factors are individual to each student and are therefore considered to be outside the control of the institution. These factors are in the four boxes outside "Institutional Commitment" in Figure 1. They are (a) a student's abilities, skills, and level of preparation for higher education, such as academic and social skills, (b) a student's attributes, such as personality, gender, social class, race, and ethnicity, (c) a student's attitudes, values, and knowledge about higher education, such as goals, drive, and motivations, and (d) the external commitments a student has, such as work and family. These factors cannot be easily changed by an institution. This research focused on the conditions that are more under the control of the institution, such as expectation, support, involvement, and feedback. They are inside the "Institutional Commitment" box in Figure 1. An institution that is committed to student success can design and implement relevant policies, practices, and initiatives to enhance the retention of students by improving these four favorable conditions in the learning environment. Such an environment can enhance the effort that students expend on learning. The more a student learns and succeeds in class after class, the more academic progress a student can make. Such learning and progress contribute to overall student success (Tinto, 2012a).

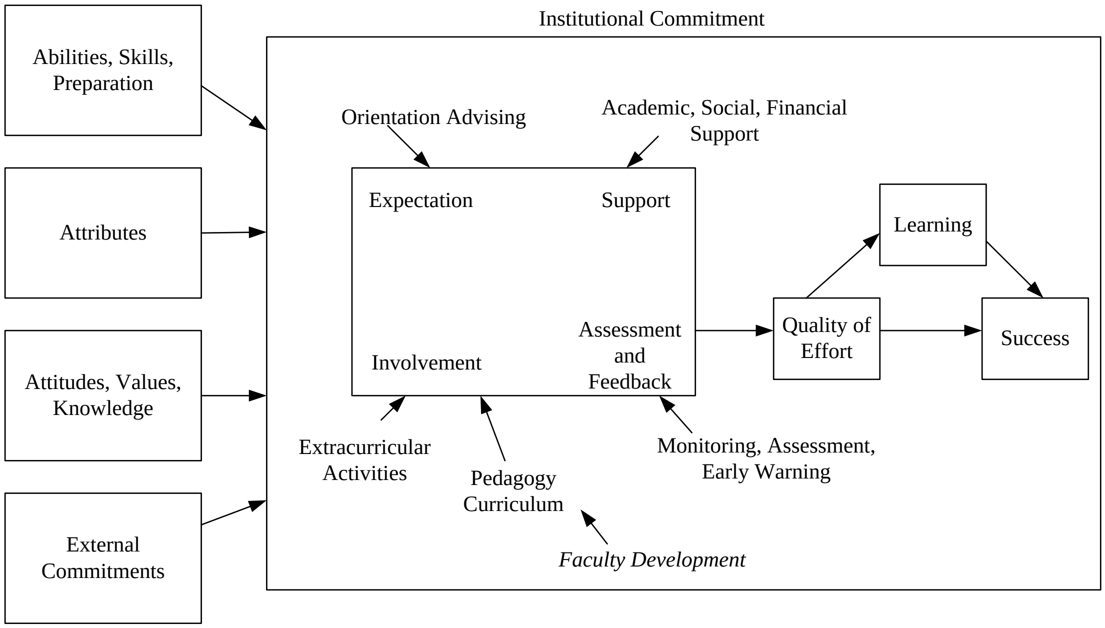

Figure 1. The Institutional Action Model. From "Moving from Theory to Action: A Model of Institutional Action for Student Success," by V. Tinto, in A. Seidman (Ed.), *College Student Retention,* 2nd ed. (New York: Rowan & Littlefield Publishers, 2012).

The first institutional commitment condition for student success is expectation (Tinto, 2012a). Students do best in environments in which clear and consistent expectations are provided. Moreover, students are even more likely to succeed when these clear and consistent expectations are high but still within their capabilities. Expectations can be communicated in concrete ways through orientations, as well as formal and informal advising. Receiving useful advising during the entrance time when a student chooses a major or when a student changes majors is particularly important.

The second institutional commitment condition for student success is support (Tinto, 2012a). Three types of support promote student success: academic, social, and financial. Academic support can be in the form of developmental education courses, tutoring, study groups, and supplemental instruction modules. Social support can be in the form of counseling, mentoring, and ethnic student centers. These centers can provide support for individual students and can act as a safe haven for minority student groups or new students who might otherwise feel isolated. Financial support is mainly in the form of grants and student loans. All such support is most effective when it is relevant to learning, e.g., connected to a particular class a student is taking, and connected to the environment in which learning takes place, e.g., the classroom.

The third institutional commitment condition for student success is assessment and feedback (Tinto, 2012a). Student success is enhanced in an environment in which performance is frequently assessed and the results are provided to faculty, staff, and the students themselves. The monitoring and assessment of student performance and providing early warning and intervention are actions that an institution can implement.

The fourth institutional commitment condition for student success is involvement (Tinto, 2012a). Involvement is also known as "engagement." Students need to be involved academically and socially for their persistence. Academic involvement can take place in the classroom and can be in the form of building educational communities. In the classroom, certain pedagogical strategies can enhance academic involvement. One such set of pedagogies includes collaborative learning, problem-based learning, and project-based learning that require students to work together in teams. Another pedagogy is service learning that requires students to provide service activities to the community that are relevant to classroom learning. A third pedagogy is the use of learning communities or cohorts, in which the same group of students take the same set of classes throughout and share their experiences. The use of appropriate pedagogies for academic involvement should be supported by proper faculty development. Social involvement can also be in the form of extracurricular activities.

This research studied various specific institutional initiatives derived from the four conditions and general initiatives mentioned in the IAM (Tinto, 2012a). Table 1 presents the four conditions and the corresponding specific initiatives. The targeted students of the IAM are traditional students. This research investigated the applicability of this model to AL students working full time and taking at least 50% of the responsibility for the care of dependents, such as children and elderly parents. The perceived usefulness of these initiatives among this group of students were studied. Among adult students, with the burden of both work and family, this group seems to be facing the highest level of time constraint. Understanding these students' views can guide higher education institutions that offer AL programs to adult working students in the right direction before they invest their resources in creating such initiatives.

Table 1. *Institutional Initiatives for the Conditions for Student Success*

Condition	**Institutional initiative**
Expectation	1. A university-level orientation, which explains the rules and regulations of the institution, the general expectation of all students, and the culture there. 2. A program-level orientation, which explains the program-level skills and expectation of student effort. 3. Before each course starts, an email from the instructor, which explains the course-level skills and expectation of student effort in this course. 4. Setting high and reasonable expectations and holding all students to these expectations fairly. 5. A personal career counseling session to help students understand which career paths are suitable for them before enrolling in a program. 6. Assigning a personal mentor (either a faculty member or an alumnus/a) who can answer questions about academic issues and career planning.

Condition	Institutional initiative
Support Academic	7. A pre-program assessment to determine whether or not a student would need to improve learning skills or take any preparatory courses to succeed in the chosen program. 8. Presenting a clear picture of how the knowledge in different courses of the chosen program fit together in an overall picture in the first course. 9. Providing a tutor in each course of the program. 10. Having a student study group available in each course of the program. 11. Providing relevant supplemental instruction modules, such as pre-recorded video clips, in addition to the normal class components in each course of the program.
Social	12. Giving students the chance to know the faculty and other students in the program or school socially. 13. Giving students the chance to know the faculty and students from their own social/ethnic background socially.
Financial	14. Giving access to more grant or scholarship money for the present education. 15. Giving access to more student loans for the present education.
Assessment and feedback	16. In addition to the exams in each course, giving constant and informal feedback to inform students and the instructor of the students' learning. 17. While students are in the program, informing them and their academic advisors early about any additional assistance needed to go forward. 18. Students maintaining a learning portfolio that documents their own academic accomplishments for reflection and self-assessment purposes.
Involvement	19. Involving students in class team projects with other equally contributing students during class time. 20. Involving students in class team projects with other equally contributing students outside class time. 21. Using cohorts to have students taking courses and interacting with the same cohort all the way through the program. 22. While students learn the material in a course, giving them the chance to apply the concepts learned (engage in proper problem-based learning). 23. Offering opportunities that give students relevant hands-on work experience, such as an internship or a service learning course. 24. Offering opportunities that allow students to join and participate in the student chapter of a professional organization in their field of study. 25. Offering opportunities for students to join and participate in an institution/school/program level alumni/ae and student online portal.

Condition	Institutional initiative
Involvement *(Continued)*	26. Offering opportunities for students to participate in a student-level contest in their field as an extracurricular activity. 27. Offering opportunities for students to attend a regular social gathering, such as an annual local BBQ or a quarterly online lecture series with the faculty, alumni/ae, and students in the school.

Literature Review

This section presents a review of literature on the retention of students in AL programs. Since the present study focused on AL students who were working full time and had dependents, relevant literature on the retention of adult students is also presented below.

While the topic of student retention has been studied for years, the topic of student retention in AL programs has only a short research history. One reason for this is that accelerated higher educational programs did not emerge until World War II (Serdyukov, 2008). Buvoltz, Powell, Solan, and Longbotham (2008) studied characteristics of students in one undergraduate AL program. The statistical results indicated that emotional intelligence and learner autonomy were important contributors to retention. Deggs (2011) performed a qualitative study on adult students in one online AL undergraduate class. The results indicated that there were three types of perceived barriers to a positive academic experience among these students: Intrapersonal barriers, such as time management skills, balance of family responsibilities, the handling of physical and emotional matters, and the fear of failure; career and job-related barriers, such as meeting job expectations and the lack of support from the workplace; and academic-related barriers, such as challenges in understanding and utilizing technology and the lack of face-to-face interaction with faculty and peers.

The bulk of research on accelerated programs or accelerated learning is on accelerated nursing programs. Stewart, Pope, and Hansen (2010) discussed the use of clinical preceptors to enhance the Accelerated Online Bachelor's to BSN (ACCEL) program in nursing. Their paper was not directly related to student retention, but it did present the successful characteristics of this program: a graduation rate of 98.33% between October 2004 and October 2006. This particular nursing program provided an orientation, short online courses, and on-campus intense laboratory and clinical experience sessions. One important feature of this program was its use of the Preceptor Model in which two local experienced nurses acted as the preceptors for a student when the student was performing several hands-on clinical practices.

Allen, Van Dyke, and Armstrong (2010) also described a similar accelerated nursing program. Although this work was not directly about student retention, it pointed out that hands-on experience was one attribute that made the program successful. Stuenkel, Nelson, Malloy, and Cohen (2011) discussed the experience of an accelerated BSN program and concluded that offering a stipend to the students to ease their financial burdens contributed to a high retention rate. This study was not based on any formal established theory or model. Rouse and Rooda (2010) reported reasons for attrition from an accelerated baccalaureate nursing program. Among two cohorts of students in the summer of 2006, the attrition rates were 29% and 50%. The study found that the students were struggling with family issues, the fast pace of the accelerated program, and the difficulty of balancing school, work, and family. Recommendations included providing a useful orientation to communicate the pace and intensity of the program, asking graduates to share their coping experiences, offering financial advice, and providing information about counseling and stress relief. This investigation was not based on any formal theory or model. Driessnack et al. (2011) recommended helping students prioritize knowledge and skills to be learned amidst the vast amount of material covered in a relatively short timeframe.

As for the self-paced teaching method commonly used in AL courses and retention, Tatum and Lenel (2012) compared the self-paced teaching method to the traditional lecture/discussion teaching method for an accelerated general psychology course. There was no difference between the two in the area of student retention. The theoretical basis of this research was the self-paced learning approach of Keller (1968). This study demonstrated that using the self-paced method in an AL course does not affect retention.

As for the retention of adult learners in higher education, Scott and Homant (2007) reported the results of a case study on a mentoring program for adult students of color. This mentor program brought some improvement in retention, but it was not statistically significant when these students were compared to a control group. Risquez, Moore, and Morley (2007) performed a qualitative study on the adjustment process of adult first-year students. The authors suggested providing mechanisms for flexible learning and assessment and proactive support to these students. Cox and Ebbers (2010) did a qualitative study on both personal and institutional persistence factors among a sample of adult female students at a community college. Positive institutional factors included a campus in which these students felt comfortable with regards to the presence of a diverse student body and supportive teachers.

Wyatt (2011) did a qualitative study on a group of non-traditional students aged 25 and above to answer the research question of how a university successfully engages non-traditional students. Based on past literature, the author first assumed engagement was good for the retention of these students, though many such students did not see engagement outside the classroom as important. Institutions could provide warm and friendly support from faculty and staff, a more physically comfortable classroom and aesthetically pleasing campus, more assistance and training in the use of academic technology, increased faculty awareness and understanding of how non-traditional students learn, a basic orientation to the campus, and information about university practices and policies. Further, institutions should understand the special needs and time constraints of these students, hence providing more flexible curricula.

Samuels, Beach, and Palmer (2011) performed a qualitative study on the persistence of a group of adult undergraduate students. It was found that an institution could enhance persistence by providing more faculty support to these students. Male students tended to focus on receiving only academic support, while female students also benefited from solicited faculty support concerning personal matters. Howley, Chavis, and Kester (2013) also performed a qualitative study on the retention of adult students in the context of a rural community college. Interviews were made with both adult students and staff. The results indicated that responsive faculty and staff, as well as flexibility in procedures to accommodate students' needs, were important institutional retention initiatives.

None of the aforementioned research had investigated working students' perceived usefulness of the complete set of institutional retention initiatives suggested in the IAM. The present study attempted to do this.

Research Methodology

Research Question and Hypotheses

The research question to be answered in this study was: Which of the institutional initiatives recommended in Tinto's IAM (2012a) do AL students working full time and assuming at least 50% of dependent care responsibility perceive to be useful?

Hypotheses H1 through H27 were for answering this research question. Due to page limits, details are listed under the section on research results. For each hypothesis tested, the null version proposeed neutrality, scoring a 3 out of 5 on a five-point Likert-type scale, with Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), and Strongly Agree (5). The opposite of each null hypothesis proposed that students are not neutral to a particular initiative (positive or negative). For example, the null version of H1 is: These students are neutral (population mean equals 3.0) about "A university-level orientation, which explains the rules and regulations of this university, the general expectation of all students and the culture here, would have been helpful to me for achieving my goal." The opposite of the null version of H1 proposes that these students are not neutral to this statement (that is, they either disagree or agree). The purpose, achieving students' academic goals, is clearly stated in each question in the questionnaire. All hypotheses, with the statistical results to be discussed later, are listed in the Research Results section.

Instrumentation

The two versions of the questionnaire used were derived directly from Tinto (2012a). One version was offered to students taking onsite classes, and the other version was offered to students taking online classes. For consistency, the questions in both versions were the same except for variations on the words "onsite" or "online," as appropriate. For objective questions, the responses were on a five-point Likert-type scale, as explained above. Open-ended questions were also included to allow the subjects to provide more in-depth answers. Questions within the questionnaire were divided into different categories that aligned with the conditions of student success in the IAM (Tinto, 2012a) and the hypotheses that had been set up. Both versions of the questionnaire are available upon request from the first author in the present study.

Research Steps

This research was a quantitative study with a questionnaire survey and statistical analysis. The major steps in the methodology were as follows:

1. Formally defining the research hypotheses based on the relevant theoretical model
2. Developing two versions of a questionnaire based on Tinto (2012a), one for students taking an onsite class and one for students taking an online class
3. Obtaining Institutional Review Board (IRB) approval
4. Performing a pre-test on each version of the questionnaire with at least two relevant students to see if any improvement on the questionnaire was necessary
5. Asking the students (subjects) to voluntarily work on an assignment for bonus points. For this assignment, each subject was given the choice of completing Version A (the questionnaire, onsite or online, as appropriate) or completing Version B (a written assignment about the course learning outcomes of the course he or she was taking)
6. Performing data cleansing and coding based on subjects' answers

7. Performing a two-tailed *z*-test statistical test for each hypothesis to determine whether or not the null version of each one should be rejected. These *z*-tests were chosen because there were 69 subjects.

Subjects

A convenience sample of current AL students was used as subjects in this study. This study used students currently enrolled at a private university (hereafter termed "XYZ University") as subjects. In order to be as comprehensive as possible, at least one onsite class and one online class offered by each college or school of XYZ University were included in data collection. XYZ University is an accredited non-profit university based in California. It offers undergraduate and graduate programs in an accelerated format. In this format, classes are conducted in a one-class-per-month approach, where each 4.5-quarter-unit class is four weeks long. A student, who only takes one class each month, takes classes in series until all the program requirements are fulfilled. A student can take such a class onsite in a physical classroom or online. An onsite undergraduate class meets 10 times during its four-week period (two times a week and two weekends). Each class lasts for 4.5 hours. An online class may still have live lecture sessions via a virtual classroom in an LMS. Similar to a traditional class session in a physical classroom, when a virtual lecture session starts, the instructor and all the students log into the same virtual classroom. Teaching and communication are synchronous via headsets and a shared computer application, such as Microsoft PowerPoint. Usually, such synchronous lecture sessions are offered once or twice a week for one to three hours, as decided by the instructor. Students taking an online course are expected to do a lot of self-learning. Usually, a student takes all the courses onsite or all the courses online. However, for a student who resides in a location where onsite classes are available, this student can take classes in both formats.

Research Results

Demographics of Subjects

Among the completed questionnaires received, a total of 69 were from students who not only were working at least 40 hours per week but had at least 50% of the responsibility of taking care of dependents, such as children and elderly parents. The respondents who returned these accepted questionnaires will be called "subjects" from here onward. Student subjects who participated in this survey were both undergraduate and graduate students, as summarized in Table 2.

None of the 69 subjects were 23 years old or under, 19 were between 24 and 33 years old, 37 were between 34 and 43 years old, and 13 were 44 years old or over. Among the 69 subjects, 68 were domestic students, and 1 did not answer this question. Among the 69 subjects, 31 were military veterans, 7 were on active military duty, 24 were civilians with no military experience, 6 did not choose any of the above, and 1 declined to answer this question.

Among the 69 subjects, 2 were taking the first course in their programs when they completed the questionnaire, 22 had taken 1 to 4 courses in their programs, 15 had taken 5 to 10, and 30 had taken more than 10 courses in their respective programs. Among the 69 subjects, 65 were not enrolled in another course for credit at the same time, 1 was enrolled in another undergraduate course, and 3 were enrolled in another graduate course concurrently. Among these 69 subjects, 67 had graduation as the major academic goal and 2 were taking courses to eventually transfer to another institution. Among the 69 subjects, 67 intended to put in their best effort in every course to learn and to succeed, 1 intended to just put in enough effort to keep in school, and 1 intended to put in effort as he/she felt like it, course by course.

Table 2. *Subjects' Academic Class, Gender, and Learning Mode (*N *= 69)*

Category	Quantity
Class	
Undergraduate	21
Graduate	48
Gender	
Male	44
Female	25
Mode	
Onsite	37
Online	32

Statistical Results

Table 3 summarizes the findings. Each row corresponds with an initiative. For each initiative, to answer the research question, a hypothesis was tested. For each hypothesis, a two-tailed *z*-test with alpha 0.05 (0.025 on each side) was used. The *z*-score for the null hypothesis to be rejected was 1.96 or higher on the positive side or –1.96 or lower on the negative side. An asterisk next to a *z*-score denoted that this *z*-score does not fall into the rejection area and thus the null hypothesis cannot be rejected.

Overall, the research results indicated that many of the initiatives derived from the IAM (Tinto, 2012a) were applicable to AL students working full time and taking care of dependents. They viewed the usefulness of nearly all initiatives positively. However, they were neutral about the usefulness of a pre-program assessment to determine the need for learning skills improvement or preparatory courses, getting access to more student loans, being involved in class team projects with other equally contributing students outside class time, a student-level contest in their field, and attending regular social gatherings with faculty, alumni/ae, and students in the school, such as an annual local BBQ party or a quarterly online lecture series. Further, they were negative about the usefulness of getting the chance to know the faculty and students from their own social/ethnic background. These results echoed with those of previous studies that, adult students do not see involvement outside the classroom as important to their persistence (Samuels et al., 2011; Wyatt, 2011).

Table 3. *A Complete View of Student Perception and Initiative Participation*

Condition	Perceived-usefulness results
Expectation	
1. A university-level orientation, which explains the rules and regulations of the institution, the general expectation of all students, and the culture there. (Q1)	H1: Positive *n*: 68 *z* score: 2.1975 *p* value: 0.0280
2. A program-level orientation, which explains the program-level skills and expectation of student effort. (Q3)	H2: Positive *n*: 69 *z* score: 4.6764 *p* value: 2.919E-06
3. Before each course starts, an email from the instructor, which explains the course-level skills and expectation of student effort in this course. (Q5)	H3: Positive *n*: 69 *z* score: 10.2245 *p* value: 1.5398E-24
4. Setting high and reasonable expectations and holding all students to these expectations fairly. (Q6)	H4: Positive *n*: 69 *z* score: 10.0995 *p* value: 5.552E-24
5. A personal career counseling session to help students understand which career paths are suitable for them before enrolling in a program. (Q7)	H5: Positive *n*: 68 *z* score: 4.0494 *p* value: 5.1340E-05
6. Assigning a personal mentor (either a faculty member or an alumnus/a) who can answer questions about academic issues and career planning. (Q9)	H6: Positive *n*: 69 *z* score: 7.6688 *p* value: 1.736E-14
Academic support	
7. A pre-program assessment to determine whether or not a student would need to improve learning skills or take any preparatory courses to succeed in the chosen program. (Q11)	H7: Neutral *n*: 68 *z* score: 1.1820* *p* value: 0.2372
8. Presenting a clear picture of how the knowledge in different courses of the chosen program fit together in an overall picture in the first course. (Q13)	H8: Positive *n*: 69 *z* score: 7.8536 *p* value: 4.044E-15

Condition	Perceived-usefulness results
Academic support—*continued*	
9. Providing a tutor in each course of the program. (Q14)	H9: Positive *n*: 69 *z* score: 7.0549 *p* value: 1.73E-12
10. Having a student study group available in each course of the program. (Q16)	H10: Positive *n*: 69 *z* score: 2.5544 *p* value: 0.011
11. Providing relevant supplemental instruction modules, such as pre-recorded video clips, in addition to the normal class components in each course of the program. (Q18)	H11: Positive *n*: 68 *z* score: 7.6218 *p* value: 2.5E-14
Social support	
12. Giving students the chance to know the faculty and other students in the program or school socially. (Q20)	H12: Positive *n*: 69 *z* score: 2.0456 *p* value: 0.0408
13. Giving students the chance to know the faculty and students from their own social/ethnic background socially. (Q21)	H13: Negative *n*: 69 *z* score: –2.8437 *p* value: 0.0045
Financial support	
14. Giving access to more grant or scholarship money for the present education. (Q22)	H14: Positive *n*: 69 *z* score: 9.6493 *p* value: 4.95E-22
15. Giving access to more student loans for the present education. (Q23)	H15: Neutral *n*: 68 *z* score: 0.3159* *p* value: 0.7521

Condition		Perceived-usefulness results
Assessment and feedback		
16.	In addition to the exams in each course, giving constant and informal feedback to inform students and the instructor of the students' learning. (Q25)	H16: Positive *n*: 67 *z* score: 10.0250 *p* value: 1.18E-23
17.	While students are in the program, getting them and their academic advisors informed early about any additional assistance needed to go forward. (Q26)	H17: Positive *n*: 68 *z* score: 12.6807 *p* value: 7.57E-37
18.	Students maintaining a learning portfolio that documents their own academic accomplishments for reflection and self-assessment purposes. (Q27)	H18: Positive *n*: 69 *z* score: 5.3636 *p* value: 8.159E-08
Involvement		
19.	Involving students in class team projects with other equally contributing students during class time. (Q29)	H19: Positive *n*: 69 *z* score: 2.121 *p* value: 0.0339
20.	Involving students in class team projects with other equally contributing students outside class time. (Q30)	H20: Neutral *n*: 69 *z* score: -0.2965* *p* value: 0.7668
21.	Using cohorts to have students taking courses and interacting with the same cohort all the way through the program. (Q32)	H21: Positive *n*: 69 *z* score: 6.8225 *p* value: 8.95E-12
22.	While students learn the material in a course, giving them the chance to apply the concepts learned (engage in proper problem-based learning). (Q33)	H22: Positive *n*: 68 *z* score: 13.5292 *p* value: 1.05E-41
23.	Offering opportunities that give students relevant hands-on work experience, such as an internship or a service learning course. (Q34)	H23: Positive *n*: 69 *z* score: 8.9556 *p* value: 3.378E-19

	Condition	Perceived-usefulness results
Involvement—*continued*		
24.	Offering opportunities that allow students to join and participate in the student chapter of a professional organization in their field of study. (Q36)	H24: Positive *n*: 69 *z* score: 5.2499 *p* value: 1.52E-07
25.	Offering opportunities for students to join and participate in an institution/school/program level alumni/ae and student online portal. (Q38)	H25: Positive *n*: 69 *z* score: 2.5169 *p* value: 0.01184
26.	Offering opportunities for students to participate in a student-level contest in their field as an extracurricular activity. (Q40)	H26: Neutral *n*: 69 *z* score: 0.0565* *p* value: 0.9550
27.	Offering opportunities for students to attend a regular social gathering, such as an annual local BBQ or a quarterly online lecture series with the faculty, alumni/ae, and students in the school. (Q42)	H27: Neutral *n*: 68 *z* score: 0.8374* *p* value: 0.4024

Limitations

This study had three major limitations. First, the sample used was a convenience sample and not a random sample. Second, data were collected from different class sections of one university and not several different universities that offered AL programs. Third, with so many statistical tests (*z*-tests) performed, the chances of finding a significant results were inflated (i.e., the chances of a Type I error was high, and significant positive or negative results may have been overestimated).

Future Research Directions

Several future research directions exist. First, this study could be expanded to use random samples from more than one university that offers AL programs. Further, among these universities chosen, it would be even better if they could be a combination of public and private universities, so as to broaden the scope of such an investigation.

Second, a qualitative study could be used to study why full-time working students do not prefer a pre-program assessment to determine whether or not they would need to improve learning skills or take any preparatory courses to succeed in the chosen program. Third, for each initiative deemed useful by AL students, further studies are needed to explore how they can be designed and executed effectively, so as to be of greatest benefit to AL students. An additional useful direction would be to assess which execution approach is the best for each type of AL student.

Conclusion

This paper has presented an empirical study to verify the IAM by Tinto (2012a). Most of the initiatives derived from this model were deemed to be useful by AL students who work full time and have dependents. However, these students were neutral about the usefulness of going through a pre-program assessment, taking on more student loans, doing team projects outside class time, being involved in student-level contests, and becoming involved socially such as attending a local BBQ party. Students were even negative about the usefulness of getting to know faculty and other students of the same social or ethnic background.

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Teacher Education

Purposeful Use of 21st Century Skills in Higher Education

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Abstract
The term, *21st century skills* is an overarching expression for the knowledge, skills, and dispositions seen as prerequisites for success in the global workplace of the future. The purpose of this article is to describe the context and definition of 21st century skills, and to illustrate how each skill may be purposefully integrated into post-secondary teaching.

Key Words
21st century skills, critical thinking, problem solving, communication, creativity, innovation, collaboration.

Introduction

The term *21st century skills* is an overarching description of the knowledge, skills, and dispositions seen as prerequisites for success in the global workplace of the future. High interest in 21st century skills is evidenced in searches of Google and Google Scholar, which show over 76 million files on the topic as of September 2015. The purpose of this paper is to describe the context and definition of 21st century skills, and to illustrate how each skill may be purposefully integrated into post-secondary teaching.

Context of 21st Century Skills

In this paper, 21st century skills are referred to using the framework put forward by the National Education Association (2012) as the 4Cs:

- Critical thinking and problem solving skills, which include reasoning effectively, using systems thinking, making sound judgments and decisions, and solving problems.
- Communication skills, which include effective oral, written and non-verbal communication in a variety of forms, contexts and technologies; listening to decipher meaning and intention; and communicating in diverse environments.
- Collaboration skills, which include working effectively and respectfully with diverse teams, exercising flexibility and willingness to accomplish a shared goal, and assuming a shared responsibility for collaborative work while valuing individual contributions of team members.
- Creativity and innovation skills, which include thinking that creates new and worthwhile ideas; and elaborating, refining, analyzing, and evaluating ideas to improve and maximize efforts.

The Partnership for 21st Century Skills (P21) was founded in 2002 by leaders from the business community, education, and policymakers to place skills that are essential for success in life at the forefront of learning for all students (2011).

Other Frameworks for 21st Century Skills

The 4Cs, 21st century skills as articulated by the National Education Association (NEA, 2012) and P21 (2011), are not the only way to conceive of abilities needed for academic and professional success in the future. The Assessment and Teaching of 21st-Century Skills (Griffin, McGaw, & Care, 2012), a consortium of educators and business communities, refer to their set of proficiencies as 21st century skills and identify them as ways of thinking; ways of working, including communication and collaboration; tools for working, including information and communication technology literacy; and ways of living in the world, including local and global citizenship, career, personal and social responsibility, and cultural awareness and competence.

The North Central Regional Educational Laboratory (NCREL, 2003) also identified four categories of proficiencies that they label as 21st century skills. These skills include digital, scientific, economic, technological, visual, and multicultural literacy, as well as global awareness, inventive thinking, effective communication, and high productivity. The NCREL report notes the urgency of mastering such skills because we live in a world transformed by technology, rapid change, and availability of vast information. Additional researchers and organizations dealing with the cultivation of 21st Century skills are all in agreement with this assessment of basic skills (Silva, 2008; American Association of Colleges of Teacher Education, 2010; Panitz & Panitz, 2015).

There is broad general agreement about the kinds of core competencies students need for current and future success, but there is also criticism. Rose (2009) noted that most lists of 21st century skills do not include mention of aesthetics or the joy of learning. Rose stated that the focus of most lists of skills is on what business needs for workplace productivity, and omits personal goals or robust goals for cultural understanding. Rose expressed concern that many who articulate 21st century skills are from business and industry and therefore propose frameworks that primarily support skills emphasizing efficiency and economic returns. Another form of objection to 21st century skills is that some of them may be used destructively. Finn (2015) suggested that critical thinking promotes a negative put-down type of thinking. Paul and Elder (2014) noted that 21st century skills can be destructive if they are not infused with intellectual virtues such as empathy, humility, courage, fair-mindedness, and perseverance. Warner (2014) suggests a return to more classical values.

21st Century Skills Not New to the 21st Century

People from ancient times also recognized the importance of what we now consider to be 21st century skills. Mention of the 4Cs can be traced back 2,500 years to Socrates and to the writings of Plato and Aristotle (Paul, Elder, & Bartell, 1997). Socrates and Plato were advocates of communication skills, intellectual development, and critical thinking, while Aristotle extolled the importance of collaboration and working in partnership with others, as well as the individual and communal need for invention or creativity (Brenegar, 2004). Rotherham and Willingham (2009) noted that the qualities currently referred to as 21st century skills have been major components of human progress throughout history and stated that “What is actually new is the extent to which . . . collective and individual success depends on having such skills ”(p. 17).

The phenomenal advance of technology heightens the need for competency in the 4Cs. Researchers frequently have suggested that the growth of technology, a rapidly changing workplace, an increasingly diverse workforce, and a highly competitive global economy have added new urgency to the need for developing 21st century skills (Bellanca & Brandt, 2010; Greenstein, 2012). A white paper released by the 21st Century Literacy Summit (2002) commented that "Information and communications technologies are raising the bar on the competencies needed to succeed in the 21st century" (p. 4).

Using the 4Cs framework suggested by the NEA (2012) and P21 (2011), the 4Cs are described in the following section, and suggestions are offered as to how they can be integrated into post-secondary teaching.

Critical Thinking and Problem Solving

Definition

Critical thinking means to reason effectively, recognizing connections between systems, concepts, and disciplines to solve problems and make decisions. Critical thinking requires clarity, accuracy, and precision of expression; relevance of arguments or questions; logic of thought; and thinking with sufficient depth and breadth to consider complexities and perspectives of an issue.

While critical thinking may at times be an individual exercise, it eventually involves others, since we do not exist outside of relationships. Therefore, critical thinking must be infused with the same virtues that support healthy relationships (P21, 2011). For example, Paul and Elder (2014) pointed out the need in critical thinking for intellectual virtues: humility as opposed to arrogance; courage as opposed to cowardice; empathy as opposed to narrowmindedness; integrity as opposed to hypocrisy; perseverance as opposed to laziness; fairmindedness as opposed to unfairness. Paul and Elder also identified the need in critical thinking for intellectual autonomy as opposed to conformity, and confidence in reason as opposed to distrust of reason and evidence.

How Critical Thinking and Problem Solving Can Be Integrated into Post-Secondary Teaching

Socrates is reported to have said, "The unexamined life is not worth living" (Brickhouse & Smith, 1994, p. 201). The meaning of his statement could be refocused by saying, "Unexamined values/ideas/concepts are not worth holding." Engaging students in personally meaningful critical thinking can be as simple as providing choice of a topic of personal interest within a subject area, or creating models to deepen interest. For example, a review of the literature could be assigned on a topic of students' choice, and requiring the presentation of differing perspectives. For greater depth, students would be required to identify assumptions and the worldview that underlie each perspective, while providing evidence of their analyses.

An example of creating a model to spark engagement in critical thinking is the 1,000-yard solar system (Ottewell, as cited in the National Optical Astronomy Observatory, 1989), an exercise that can create awe for young and old alike. A full description of the model is not possible here, but one observation includes relative sizes of planets and distances between them. For example, the dwarf planet Pluto is the size of the point of a pin in the model, and 1,000 yards from an 8-inch sun. What questions might we want to ask about the system? What inferences can we make? What principles of science does the model demonstrate? Use of the model could generate a wide array of critical thinking, from investigating pure science to implications for a worldview. Note that embarking on critical thinking is certain to include other 21st century skills: communication, collaboration, and creativity, and problem solving.

Communication Skills

Definition

Communication refers to the ability to effectively articulate, receive, and give feedback on thoughts and ideas transmitted orally, in writing, visually, through use of technology, or via non-verbal communication (NEA, 2012). Communication also includes the effective use of listening skills to interpret meaning, including the use of emotional intelligence to infer values, attitudes, and intentions. Stephen Covey (1989), popular author of the well-known book, *7 Habits of Highly Effective People,* highlighted the importance of communication as a life skill. In the 5th habit, Seek First to Understand, Then to Be Understood, Dr. Covey reminded us that most people listen in order to respond, rather than listen to enhance understanding.

A significant aspect of communication is that it requires a two-way interchange of information (a message and feedback) that forms a connection between two or more people. Effective communication requires that the message be transmitted, heard, and understood within the context of intellectual virtues. This interchange provides the vital “human touch” that is necessary for activating and/or demonstrating the other 21st century skills. As noted in the NEA (2012) report, communication competencies such skills as clearly articulating ideas through speaking and writing are closely linked to collaboration skills such as working effectively with diverse teams, making necessary compromises to accomplish a common goal and assuming shared responsibility for collaborative work (p. 14).

Well-developed communication skills provide students with a distinct advantage in academic settings as well as in future workplace settings. Throughout history, effective communication skills have been highly valued and viewed as essential for achieving professional success. Business and education researchers agree that communication skills are vitally important for citizens in the 21st Century. The 1983 report, *A Nation at Risk*, addressed the workforce skills that will be required to maintain U.S. economic success in the coming century. The report underscored the importance of communication skills, which include “participating in a team, teaching others new skills, serving clients and customers, exercising leadership, negotiating, and working with diverse groups of people” (as cited in the Secretary’s Commission on Achieving Necessary Skills, 1991, p. 81). A number of current research efforts focus on this theme that the U.S. workforce will need to possess 21st century skills in order to ensure the nation’s competitive edge in the global economy (Educational Testing Service, 2002: Bellanca & Brandt, 2010; NEA, 2012).

Educators and educational institutions from pre-kindergarten through college level are under pressure to prepare students to be effective communicators. Prior to the recent revolution in technology, communication included oral, written, and nonverbal forms of information exchange. However, institutions of higher education must now work with students in a whole new layer of information and communication technology required to thrive in the digital age (Educational Testing Service, 2002).

Communication skills have obvious need in social and personal spheres. For example, Goleman’s (2012) studies on emotional intelligence suggested that individuals possessing superior communication skills tend to have more personally and professionally successful lives than those who do not.

How Communication Skills Can Be Integrated into Post-Secondary Teaching

The *Framework for 21st Century Skills* document developed by P21 (2011) presented a comprehensive list of communication skills, knowledge, and abilities required for student and future worker success in the global economy. These skills can be integrated into post-secondary teaching and could include the following types of student assignments:

- Deliver presentations, prepare reports, conduct meetings, lead groups, demonstrating ideas using visuals, graphics, multi-media, and other nonverbal means or technology-related tools.
- Review, evaluate, critique, and report on communications efforts delivered by others, demonstrating accurate interpretations of information, knowledge, values, attitudes, and intentions. (Includes nonverbal communication.)
- Collaborate and cooperate with others on group projects that require interpersonal skills and involve successful interaction with others while working on a shared goal or project.
- Prepare and evaluate videos, multi-media presentations, and other technology-related projects/products to demonstrate knowledge and appropriate use of technology.
- Develop communication materials or techniques that show sensitivity to diverse environments and diverse audiences (P21, 2011).

Collaboration

Definition

P21 (2011) defined collaboration as the ability to “work effectively in diverse teams, make compromises to reach a common goal, and value each individual’s contribution” (p. 19). As in the business world, skills required in the academic environment are networking, time management, resilience, good presentation skills, and leadership skills. Higher education faculty members need a network of connections to assist them in collaborating with others.

Many university professors are adding a social component to distance learning. One professor at DePaul University wanted a way to collaborate both inside and outside the classroom (Yeh, 2008). Distance learning tools from Blackboard and Wimba were used to improve learning experiences and increase interactions between students and faculty. Social learning is still in its infancy when used in college classes; however, the need to increase collaboration is pushing the use of social media to accomplish those objectives (Yeh, 2008).

During the industrial age, work was accomplished primarily by individuals. In today’s service oriented climate, teams often accomplish work in both business and educational settings, both nationally and internationally (NEA, 2012). Instructors need to offer many opportunities for collaboration in both onsite and online classes. The online format can be challenging, but some instructors have put students in groups that connect to their particular interests for the purpose of creating a group project. There might also be an option of taking a test or writing a paper with a partner. There are many benefits to collaboration. Trilling & Fadel (2009) offered the following ideas:

- *Provide access to skills and strengths*—collaborating will enable members of the team to share knowledge and work with someone who can present the ideas in the best fashion.
- *Develop skills*—team members benefit from collaboration because, as a result of sharing ideas and working together, they see how others think, negotiate, and operate. The skills and knowledge that each team member can pick up from others can be utilized or taken back to make improvements or enhancements.
- *Solve problems and innovate faster*—what may take a team member three months to solve alone should take only a few hours to come up with ideas gained in a group.
- *Make work more efficient*—collaborating teams allow teachers to work in a more efficient manner. Work can be distributed more evenly and efficiently to those who have the time and expertise.
- *Increase Job satisfaction*—working with others in a meaningful way helps team members feel good about what they do. When you can share your "wins" with others, you often build a sense of team. Team members are more likely to stay longer when they have strong bonds with others around them and feel they are a part of something important. This bonding is a result of synergy, an outcome of creative teamwork in which more is accomplished, and finds better solutions than when individuals work only on their own.

How Collaboration Can Be Integrated into Post-Secondary Teaching

P21 has made alliances with many key national organizations. One of these is the Collaborative Online Research and Learning (CORAL), a task force with members from various universities who create and test models that integrate technology with teaching and learning (NEA, 2012). Students might be asked to use this resource to collaborate on a presentation, paper, or other assignment.

Global Learning and Observations to Benefit the Environment (GLOBE) is a program that works worldwide to create a hands-on, school-based science and education program. Teachers and scientists collaborate with NASA, NOAA, and NSF Earth System Science Projects. This network has representatives from 111 participating nations coordinating their activities with local and regional communities (NEA, 2012). GLOBE would offer a plethora of ideas for group assignments in the science field.

The Partnership in Learning has also developed many classroom resources such as creating rubrics, using groups effectively, creating online professional learning communities, and translating good teaching practices to the virtual classroom. Resources from the Department of Education provide teachers with a guide to international collaboration on the Internet (NEA, 2012).

In an effort to make online and onsite courses more relevant to match the needs of 21st-century students, many options need to be tried. Motivation does increase when an instructor includes experiences with social media, podcasts, blogs, and other practices that require feedback and interaction with fellow students in a class.

Creativity and Innovation

Definition

Creativity and innovation involve generating new and worthwhile ideas as well as refining ideas that already exist. Creativity and innovation include being open and responsive to new ideas—recognizing that these qualities can be enhanced through small successes and frequent mistakes (NEA, 2012).

Creative people use a wide range of idea-creation techniques, including brainstorming, mind-mapping, doodling, and diagrams. They are interested in trying out original ideas, elaborating, refining, and working to improve them. Creativity often involves working on a project with others and being open to various perspectives. Creative people work toward being inventive and original and view failure as an opportunity to learn from mistakes (NEA, 2012). Sir Ken Robinson, considered one of the great thinkers on the subject of creativity and innovation, insisted that creativity is not only for the arts but should be embedded in math, science, history curricula, and in all disciplines (*Language Arts* Staff, 2014). Another thinker on the subject of creativity is Robert Sternberg, a psychology professor at Cornell University well known for his research on such topics as intelligence, creativity, and thinking styles. He explained creativity this way:

> Creativity isn't something you're born with. It's partially a skill, but it's largely an attitude. It's about coming up with ideas that are novel, that are new, that are useful in some way, and that are relevant to whatever you are trying to accomplish. (as cited in *Language Arts* Staff, 2015, p. 379)

Sternberg reminded us that students learn in different ways. They need learning opportunities that "encourage them to explore, discover, invent, seek new challenges, create, imagine, suppose" (as cited in *Language Arts* Staff, 2015, p. 381).

How Creativity Can Be Integrated into Post-Secondary Teaching

Instructors who want their students (both online and onsite) to be more engaged and creative are beginning to share their ideas on college websites, at conferences, and in journal articles. To employ more creativity in assignments, the instructors' goal should be making "the assignment clear and focused but allowing real freedom in how the tasks will be accomplished" (NEA, 2012, p. 27). If instructors model creativity in the way they structure assignments, their students will be more willing to take a chance in trying something new. Appendix A offers some examples of assignments in all fields that motivate students to solve real problems, create innovative projects, and engage with topics in a fresh, new way.

Why Are Creativity and Innovation Important?

"In today's world of global competition and task automation, innovative capacity and a creative spirit are fast becoming requirements for personal and professional success" (NEA, 2012, p. 24). Howard Gardner (2007), Richard Florida (2005) and Daniel Pink (2006), well known educational writers, all agreed that creative thinking skills will be more and more crucial to our country's future. Gardner described "the creating mind" as one of the five minds we will need in the future. To cultivate such a mind, he wrote, "we need an education that features exploration, challenging problems, and the tolerance, if not active encouragement of productive mistakes" (p. 20). Unfortunately, the focus on test scores and pressure on schools and teachers to raise test scores severely limits purposeful teaching of creativity. The *Language Arts* Staff (2015) noted similarly,

> The ways of thinking learned in school often don't serve [students] very well when they get out of school. The world changes pretty quickly . . . Job skills change . . . If you're not a lifelong learner and a creative thinker, it's going to be really hard for you to meet the challenges of the future. (p. 380)

According to a recent IBM poll of 1500 CEOs, creativity was identified as the number-1 leadership competency of the future (Bronson & Merryman, 2015, para. 7). National and international problems need creative solutions. Creativity is declining in students when creative solutions are needed more than ever. According to all researchers cited in this paper, a greater focus on creativity is needed in all levels of education.

> There is a growing consensus that America's economy will be increasingly based on creativity or what the writer Daniel H. Pink calls "high touch" and "high concept" skills . . . . To stay competitive, America will need to draw on its ability to tell stories, create visually compelling messages and designs, come up with new ways to organize and synthesize information, and invent programs and businesses to solve complicated social problems or tap emerging markets. Business leaders are demanding those skills. (Lingo & Tepper, 2010, p. 2)

Conclusion

While it is useful to distinguish between specific 21st century skills, in practice they are closely intertwined. For example, one cannot engage in meaning-making without some level of critical thinking, without taking into consideration the perspectives of others, without interacting with others, or without considering alternatives. True education is seeing connections between ideas, concepts, and disciplines in ways that help students understand the relationships and the relevance of ideas to people and new situations. Thus, when engaging in one 21st century skill, the others are engaged in to varying degrees. As the 21st century progresses, great professors will look for ways to thoughtfully embrace the 4Cs and to encourage more critical thinking, better communication, collaboration, and creativity in their own professional lives, as well as in the quality of their students' learning experiences. Please see Appendix A which illustrates several assignments or examples to teach critical thinking, collaboration, communication, and creativity."

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Appendix A
Suggested Assignments/Examples

Critical Thinking

1. Select a news story. Respond to:
   a. Who is the intended audience?
   b. What point of view is being privileged …downplayed? …ignored?
   c. What other sources of information about the story are available – and how do they report the same story?
   d. What vested interests or passions are associated with the content?
   e. What evidence is there of the writer's worldview?
2. Read a journal article, and in one page or less (double spaced) summarize what the article is about, what you believe are the strengths of the journal article, and what you believe to be the limitations.
3. On a topic that has some controversy (a particular piece of legislation; an ethical issue; or particular trend such as assessment or Common Core State Standards): Identify at least two perspectives on the issue and the rationale, and beliefs or assumptions related to the perspective. State the perspective you are most likely to support and why.
4. Create a portfolio that uses a variety of media/interactivity to demonstrate mastery of learning.

Communication

1. Design and develop white paper and oral report on topic suitable to class, using visuals and multi-media tools for presentation to individuals or groups.
2. Classmates evaluate and submit review of peer presentations using rubric and including brief summary of content.
3. Group of students prepare and submit a video or multi-media presentation that represents multiple viewpoints on a controversial issue or problem appropriate to the subject matter of the courses.
4. Student groups develop and submit peer evaluation of the student prepared videos/multi-media presentations.
5. Each student submits a journal report on the personal dynamics and process of their team's production of the video/ multi-media presentation.

Collaboration

1. Connect with students in other classes who have set up pen pals with students nationally and internationally.
2. Research the effectiveness of Collaborative Learning
3. Complete an annotated set of 10 websites on collaboration and share with the class via a power point.
4. Students respond to how Common Core is implemented in their School Districts via their Facebook page.
5. Students are put in groups to set up a blog on a topic set by the Professor.

Creativity

1. Update the literature. Ask students to update a literature review done about five years ago on

a topic in the discipline. They will have to utilize printed and electronic resources to identify pertinent information.
2. Concept mapping. Have students create visual representations of models, ideas, and the relationships between concepts. They draw circles containing concepts and lines, with connecting phrases on the lines, between concepts.
3. Culture shifts. Using the New York Times Historical database, have students select a topic or an issue and examine it across time by locating articles in the New York Times for this year, 25, 50, 75, and/or 100 years ago. Students can study the different approaches to the issue and the ways in the issue reflect the values and assumptions of the time.
4. Write your own exam. Write an exam on one area; answer some or all of the questions (depending on professor's preference). Turn in an annotated bibliography of source material, and rationale for questions.

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Combining Professional Development & Instructional Coaching to Transform the Classroom Environment in PreK–3 Classrooms

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Abstract
This 2-year study examined the impact of mathematics-focused professional development and instructional coaching support on classroom quality in five inner-city Catholic elementary schools. The results demonstrated that in two major domains there was a noted increase in classroom quality when comparing pre- and post-data. The domain of classroom organization demonstrated significant improvement with instructional support, also demonstrating positive gains. The domain of emotional support did not demonstrate significant improvement when comparing pre- and post-data results.

Keywords
Classroom environment, instructional coaching, professional development

> Young learners' future understanding of mathematics requires an early foundation based on a high-quality, challenging, and accessible mathematics education. Young children in every setting should experience mathematics through effective, research-based curricula and teaching practices. Such practices in turn require that teachers have the support of policies, organizational structures, and resources that enable them to succeed in this challenging and important work.
>
> National Association for the Education of Young Children (NAEYC, 2002, 2010, p. 1)

The shortage of qualified science and mathematics teachers is a growing problem throughout the United States. Not only is there a shortage of teachers, but also the teaching of science and mathematics in the United States is falling short in preparing future generations with analytic skills. Although United States mathematics scores of children are moving in a positive trajectory on a global comparison, the current U.S. ranking within the top 15 nations suggests there is much room for improvement. The Fifth International Mathematics and Science Study (Mulis, Martin, Foy, & Arora, 2012) reported that an early start is crucial in shaping children's numeracy skills. Increasing evidence shows that participating in numeracy activities during the early years can have beneficial effects on children's later acquisition of important numeracy skills. Overall, students with the highest mathematics achievement typically attend schools that emphasize academic success, as indicated by rigorous curricular goals, effective teachers, students that desire to do well, and parental support (Mullis et al., 2012).

In high-poverty schools in the United States, the incidence of science and mathematics teachers teaching without even a minor in science or mathematics is even more frequent than in more affluent schools. Additionally, in high-poverty schools it is also more prevalent that licensed teachers will teach out of their field (Ingersoll, 1999). Students attending schools with a high minority population have a 50% chance of being taught by teachers who hold neither a license nor a degree in mathematics or science (Ingersoll, 2002). This is just not a concern for secondary students. Teachers of young children should have the acquired competencies and skills in mathematics content to be highly effective when teaching. Furthermore, for experienced teachers, the lack of appropriate preparation may contribute to a failure to see mathematics as a priority for young children and result in lack of confidence in their ability to teach mathematics effectively (Sarama & DiBiase, 2004). Nonetheless, having content knowledge alone is not enough to ensure teacher competency. Essential as mathematical content knowledge is, content knowledge can only be effectively utilized when teachers themselves possess positive attitudes about the importance of mathematics.

While pre-service teacher preparation programs need to create a sense of urgency around the mathematics component of early childhood programs, in-service professional development programs for early childhood teachers should also be designed to support high-quality mathematics education. Teaching mathematics effectively needs to be a career-long goal; teacher learning needs to be generative (Kilpatrick, Swafford, & Findell, 2001; Copley, 2004). Consequently, the delivery of professional development experiences must foster the desired learning outcomes for both teachers and children (NAEYC, 2001). Effective professional development experiences weave together mathematics content and pedagogy within the context of early child development (Ball & Cohen, 1999). Professional development partnerships between higher education institutions and local PreK–3 grade schools can serve as a vehicle that supports teacher growth through ongoing professional development in content areas such as mathematics.

Conceptual Framework

Professional Development

Several characteristics of effective professional development have emerged from recent research. First, successful professional development programs support teachers as they gain content knowledge and acquire instructional strategies (Long, 2012). Next, effective programs provide opportunities over time for teachers to reflect deeply (Donnelly et al., 2005) as they focus on research-based practice (Brooke et al., 2005; Kedzior & Fifield, 2004). In addition, studies confirm success when professional development is engaging (Donnelly et al., 2005) and collaborative (Hurd & Licciardo-Musso, 2005; Mahn, McMann, & Musanti, 2005). Thus, professional development programs need to be extensive while continuously focusing on specific topics (Kedzior & Fifield, 2004; Long, 2012). Additionally, if the goal is to provide teachers with engaging professional development experiences, then understanding the impact on student and teacher outcomes is critical.

The expansion of teacher knowledge has traditionally been cultivated through professional development activities. Studies examining teacher change have suggested that traditional in-service training carries risks of superficiality and fragmentation. Darling-Hammond and Richardson (2009) found that traditional professional development focused on one-shot workshop models with emphasis on training teachers in new techniques; unfortunately, this model has had little to no effect on student learning. To ensure the development of teaching proficiency, in-service professional development needs to move beyond the one-time workshop to deeper exploration of key mathematical topics as they connect with young children's thinking and with classroom practices. Professional development in mathematics education needs to be sustained over time.

To counter fragmented professional development, the new professional learning models are designed as lifelong collaborative learning processes that support a job embedded, learner-centered approach. The recently published *Standards for Professional Learning* (Learning Forward, 2011) reflect this shift from the traditional delivery models and emphasize the need for educators to take active roles in their professional learning and development. This movement away from the traditional professional development model emphasizes the need for schools to become learning communities that support the growth of both teachers and students (Darling-Hammond & Sykes, 1999; Drago-Severson, 2009). The most salient variables in school improvement efforts appear to be teachers and their classroom practices (Reeves, 2010); thus, support for the development of effective learning communities may be provided by adding coaching to the model (Knight, 2007).

Instructional Coaching

Although in theory effective professional development offers opportunities for new learning and contributes to a culture of school change, Bully, Coskie, Robinson, and Egawa (2006) cautioned that actual change in practice is rare, and "fewer than 10% of teachers actually implement instructional innovations following workshops or in-service experiences" (p. 27). Change in teacher practices is more likely to occur if teachers are provided with a mentor or coach who is physically present and engaged in supporting, encouraging, and guiding them (Bloom, Castagna, Moir, & Warren, 2005; Knight, 2007; Reeves & Allison, 2009). If workshops and professional development in-service experiences alone are insufficient to change teacher practices, then the role of an instructional coach becomes critical. Instructional coaching affects the school culture, supports significant change, promotes reflection and decision-making, and honors adult learners (Toll, 2005). Research suggests that teachers hold the key to student achievement (DuFour, 2007; Guskey, 2000; Roy & Hord, 2003). According to Yoon, Duncan, Lee, Scarlos, and Shapley (2007), teachers who receive substantial professional development can boost their students' achievement by approximately 21 percentile points. Unfortunately, Yoon et al. (2007) also claimed that, of the 1,300 relevant studies on professional development from 1986 and 2006, only 9 studies met the standards of high quality professional development set by the Institute of Educational Science's What Works Clearinghouse. Additionally, according to Byington and Tannock (2011), teachers in the early grades would benefit from strengthening the quality and quantity of professional development being offered.

Viewed through the lens of adult learning, instructional coaching is a means of conveyance, supporting the movement of a teacher from where the teacher is to where the teacher wants to be (Costa & Garmston, 2002; Evered & Selman, 1989). Using the model of Joyce and Showers (1995), the important role of instructional coaches in professional development is clearly evident. Joyce and Showers proposed five kinds of support for teachers: theory, demonstration, practice, feedback, and in-class coaching. They found, when feedback and in-class coaching were combined with the theory, demonstration, and practice, there was an increase in teacher knowledge and eventually classroom practice. In a study of urban instructional coaches, Blachowicz et al. (2010) found that instructional coaches' effect on the "instruction and infrastructure of the school emerged as one of the top three influences for change . . ." (p. 348). However, sustainable change is not easy to achieve and requires altering habits as well as creating new routines (Knight, 2007). The support offered through instructional coaching may be one approach to sustainable change in the classroom environment.

Classroom Environment

Evidence is clear that the quality of early childhood programs affect children's academic growth and development (National Research Council, 2000). Lambert, Abott-Shim, and Sibley (2005) identified five dimensions that relate to classroom quality across classrooms, with three focused on classroom dynamics, classroom structural variables, and classroom staff characteristics (Lambert et al., 2005). Further, effective early childhood programs have been found to include:

- An emotionally supportive classroom that fosters healthy relationships and some level of student autonomy (Curby et al., 2009; Pianta, LaParo, & Hamre, 2008).
- A well-organized classroom that provides opportunities to maximize student learning, establishes order, and engages students in the learning experience (Emmer & Stough, 2001; Pianta et al., 2008).
- An instructionally supportive classroom provides constructivist-learning experiences that assist students in making significant connections to the real world (Pianta et al., 2008).

These three dimensions examine the interaction between teachers and students in the early childhood classroom, rather than evaluating the presence of materials, classroom environment, or the type of curriculum that exists within a school (Pianta et al., 2008). Researchers have suggested that children who are motivated and connected to others in the early years of schooling tend to establish positive trajectories in academic domains such as mathematics (Hamre & Pianta, 2001; Ladd, Birch, & Buhs, 1999; Pianta, Steinberg, & Rollins, 1995; Silver, Measelle, Essex, & Armstrong, 2005). Thus, teachers' abilities to support social and emotional needs in the classroom are an important domain of classroom practice. As presented in Appendix B, research conducted by Pianta et al. (2008) has indicated relatively small mean changes within the aforementioned sub-dimensions. Specifically, "The data indicate small changes in mean scores and correlations range from .64 from Behavior Management to .25 for Quality of Feedback" (Pianta et al., 2008, p. 100). Additionally, researchers reported low levels of stability in instructional support in comparison to the other dimensions. Although the results cannot be generalized across other grades, the results provide a unique perspective on the type of interaction observed in classrooms.

Classrooms function at their highest levels when students are actively engaged in learning tasks; therefore, teachers' skills in managing well-organized classrooms can have a significant impact on student learning (Pianta et al., 2008). In addition, student learning is also enhanced through beneficial student-teacher interactions. Within the classroom, the teachers' ability to support cognitive and language development is a critical dimension to the overall classroom environment necessary to support mathematical learning in early childhood (Pianta et al., 2008).

A review of literature revealed little in the follow-up of in-service teachers once they have entered the field. This gap in the literature suggests a need for measures of teacher knowledge and skills, implementation of effective pedagogical practices, and use of emerging, evidence-based curricula (Horm, Hyson, & Winton, 2013). Furthermore, there is a need to field test and evaluate the influence of professional development on classroom practice.

Research Methodology

Context and Purpose of Study

This study is part of a larger 3-year investigation into the impact of mathematics professional development and instructional coaching on teacher pedagogical and content knowledge and students' mathematic achievement in early childhood education. This particular aspect of the study analyzed the impact of mathematics-focused professional development in tandem with instructional coaching on the quality of PreK–3rd classrooms. Classroom quality is defined by the interactions between teacher and student that can affect student achievement. Figure 1 portrays the Classroom Assessment Scoring System (CLASS) domains and dimensions that were used to assess classroom quality in this study (Pianta et al., 2008).

Emotional support:

- Positive climate
- Negative climate
- Teacher sensitivity
- Regard for student perspectives

Classroom organization:

- Behavior management
- Productivity
- Instructional learning formats

Instructional support:

- Concept development
- Quality of feedback
- Language modeling

Figure 1. CLASS domains and dimensions.

This project provided ongoing professional development and part-time instructional coaching designed to support early childhood teachers in improving mathematics instructional delivery and the overall classroom environment. Monthly professional development workshops were provided over a 2-year span to support early childhood teachers' mathematical content and pedagogical knowledge. In these ongoing sessions, teachers were introduced to a variety of instructional strategies that support the development of students' mathematical learning as well as their own mathematical content knowledge. Professional development workshops were offered in 3-hour sessions that examined early numeracy topics, demonstrations and modeling of mathematics strategies, assessment tools, and classroom management models. Professional development sessions also addressed classroom-environment issues that might impact the delivery of quality instruction, such as using hands-on materials and allowing students extended time to practice new skills.

Since professional development alone might leave teachers without the support needed to apply knowledge in classroom practice (Knight, 2007), part-time instructional coaching was added as a means to support teachers in the application of this new knowledge into their professional practice. In this study, each instructional coach was assigned to support one team of five PreK–3 teachers. Instructional coaches observed, provided feedback, engaged in modeling, and co-taught with their team of teachers for a minimum of 15 hours per month; the ultimate goal was to improve three classroom quality domains (emotional support, classroom organization, and instructional support) and support the implementation of research-based mathematics strategies.

Population and Participants

This particular study was part of a larger study that involved a 3-year university-school partnership supported by funds from a private grant foundation. Principals from 76 Catholic elementary schools from urban communities in Chicago were notified of the grant proposal process and expectations. The principal of each school, if interested, was asked to submit a formal application. Each application submitted went through a peer review process by four evaluators who rated each application based on specific criteria (school size, identified need, and percentage of students receiving free or reduced lunch). Of the eight schools that applied, five schools were chosen to participate.

Once selected for the project, PreK to 3rd grade teachers and administrators at each school were provided with an overview of the project expectations. Based on the number of PreK-3 teachers in each school, three of the five schools were assigned one instructional coach while the remaining two schools were assigned two instructional coaches. Each of the seven coaches was assigned to one team of PreK–3 classroom teachers. A total of 26 PreK–3 grade teachers participated in the project. Table 1 provides details of the number of teachers and coaches assigned to each school.

Table 1. *Coaching Pairings*

School Name	**No. of Teachers (PreK–3)**	**Instructional Coaches**
School 1	4	1
School 2	4	1
School 3	4	1
School 4	7	2
School 5	7	2
Totals (5 Schools)	26	7

Data Collection Instrument

The Classroom Assessment Scoring System (CLASS) instrument is an observational protocol developed at the University of Virginia and is based on years of educational and developmental research, as well as scales used on large classroom observation studies by the National Institute of Child Health and Human Development Study of Early Care (Pianta, LaParo, Payne, Cox, & Bradley, 2002). To understand the extent that mathematics-focused instructional coaching had on classroom quality in participating PreK–3 classrooms, the CLASS observation tool was implemented (See Appendix A).

The CLASS observation instrument was initially developed as a tool for research on early childhood development. The focus of the CLASS tool is on interactions between students and teachers as the primary mechanism of student learning. Observation scoring is based on a 7-point scale; scores are assigned based on alignment with anchor descriptions at low (1, 2), middle (3, 4, 5), or high (6, 7) (Pianta et al., 2008).

Methodology and Methods

Prior to data collection, the instructional coaches were trained in collecting baseline data. Baseline pre- data was collected during the spring 2011 academic year prior to any formal mathematics-focused coaching. Instructional coaches conducted a total of 119 pre-observations, which averaged approximately four 20-minute observations per teacher. Similarly, instructional coaches conducted a total of 119 post-observations, which averaged more than five 20-minute post-observations for each teacher during spring of the 2013 school year.

The researchers wanted to understand if there was a significant difference in pre-observation (data collection) and post-observation scores; thus a *t*-test was conducted. Specifically, the researchers examined the data to determine if there was a statistical difference when comparing the major domains of emotional support, classroom organization, and instructional support. Additionally, a *t*-test was used to determine if a significant statistical difference occurred when comparing pre- and post-data collected within the dimensions of the three major domains. The following specific null hypotheses guided this study:

1. There is no statistically significant difference between pre- and post-data collection periods of the major domains of classroom quality.
2. There is no statistically significant difference between pre- and post-data collection period within the dimensions of the three major domains of classroom quality.

CLASS data was examined to obtain composite scores across cycles within the pre- and post-data collection periods; individual observations for each dimension were averaged across the number of observations completed (Pianta et al., 2008). Scores for dimensions within each of the three domains were obtained by averaging the related dimensions within each domain. In reviewing these results, it should be noted that the negative climate is scaled in the opposite direction of the other CLASS scales; therefore, higher negative scores indicate lower quality. Thus, the average score for negative climate is reversed; "to reverse the score, subtract the average NC (Negative Climate) from 8" (Pianta et al., 2008, p. 19).

Analysis was conducted using a *t*-test to determine if there was a significant statistical difference when comparing pre- and post-data collected on the major domains of emotional support, classroom organization, and instructional support. Additionally, a *t*-test was used to determine if a significant statistical difference occurred when comparing pre- and post-data collected within the dimensions of the major domains.

Results

Data from the five schools were combined to understand the relative impact of mathematics-focused professional development delivered in tandem with instructional coaching. Table 2 indicates that in every major domain there was a noted increase in classroom quality. Of the three domains, emotional support had the smallest identified increase when comparing pre- and post-data results. Classroom organization, which includes behavior management, productivity, and instructional learning formats, had an initial average demonstrated the largest gain. The domain of instructional support had an initial average of 3.81 (pre) with a final mean of 4.19 (post), which demonstrated an increase.

The *t*-test revealed a significant difference when comparing pre- and post- scores of each domain with the exception of emotional support. Thus the first null hypothesis (1) was rejected. Mathematics-focused professional development and instructional coaching had a significant positive impact on the quality of teachers' classrooms with respect to the major domains of classroom organization and instructional support. Additionally, the researchers wanted to understand the relative strength (effect size) in comparing pre- and post- mean. Cohen's *d* was calculated and the results indicated a small to large effect in comparing pre- and post- mean scores within each domain. Classroom organization had the largest effect, while instructional support revealed small effect. Table 3 provides complete details of the data collected.

Table 2. *Descriptive Statistics Analyzing the Three Domains Across All Schools*

Major Domains	**Collection**	***N***	**Mean**	**Std. Dev.**	**Std. Error Mean**
Emotional support	pre-	119	5.16	1.03	.09
	post-	119	5.25	.85	.08
Instructional support	pre-	119	3.81	1.15	.11
	post-	119	4.19	1.22	.11
Classroom organization	pre-	119	4.68	.89	.08
	post-	119	5.30	.66	.06

Note. *N* = number of observations.

Table 3. *Paired Samples* t-*Test Comparing Mathematics-Focused Professional Development (Pre- and Post-)*

	Paired differences			**95% CI**					
Collection	***MD***	***SD***	***SE***	**LB**	**UB**	***t***	***df***	***p***	***d***
Emotional support pre- vs. post-	–.08	1.33	.12	–.33	.16	–.68	118	.50	.09
Classroom organization pre- vs. post-	–.70	1.03	.09	–.88	–.51	–7.37	118	.00	.89
Instructional support pre- vs. post-	–.38	1.71	.16	–.69	–.07	–2.40	118	.02	.32

Note. *MD* = Mean Difference, *SD* = Standard Deviation, *SE* = Standard Error, CI = Confidence Interval, LB = Lower Bound, UB = Upper Bound, *d* = Cohen's *d*.

In addition, it was important to understand to what extent mathematics-focused professional development and instructional coaching had an impact on the dimensions within each major domain. Descriptive statistics revealed a positive increase in every dimension in the domains of classroom organization and instructional support. With respect to the dimension of emotional support, data indicated an improvement in classroom quality with respect to teacher sensitivity and regard for student perspectives but a decrease in the overall positive climate. Table 4 provides complete details of the data collected.

A *t*-test was conducted to determine which dimension within each domain indicated a significant positive improvement. With respect to the domain of classroom organization and instructional learning, the data indicated a significant improvement in every dimension with the exception of quality feedback. With respect to emotional support, the data suggested that regard for student perspectives did improve significantly; however, the dimensions of positive climate significantly decreased and negative climate did not significantly improve. Additionally, the researchers wanted to understand the relative strength (effect size) in comparing pre- and post- mean of each dimension. Cohen's *d* was calculated and the results indicated a small to moderate effect in comparing pre- and post- mean scores within several dimensions. Language modeling, instructional learning format, and productivity had the highest overall medium effect. The remaining dimensions had a small or no effect over time. Table 5 provides complete details of the data collected.

Table 4. *Descriptive Statistics Analyzing the Dimensions Within the Three Domains Across all Schools*

Dimensions	**Collection**	***N***	**Mean**	***SD***	***SE***
Positive climate	pre-	119	5.18	1.24	.11
	post-	119	4.70	1.25	.12
Teacher sensitivity	pre-	113	4.67	1.18	.11
	post-	113	5.00	1.36	.13
Regard for student	pre-	119	4.36	1.24	.11
Perspective	post-	119	4.70	1.25	.12
Negative climate	pre-	119	6.44	1.14	.10
	post-	119	6.61	.76	.07
Behavior management	pre-	118	4.67	1.28	.12
	post-	118	5.25	1.04	.10
Productivity	pre-	118	4.86	1.00	.09
	post-	118	5.51	.95	.09
Instructional learning	pre-	119	4.28	1.12	.10
format	post-	119	5.18	1.29	.12
Concept development	pre-	117	3.82	1.30	.12
	post-	117	4.23	1.56	.14
Quality feedback	pre-	106	3.77	1.19	.12
	post-	106	4.00	1.24	.12
Language modeling	pre-	70	3.74	1.25	.15
	post-	70	4.66	1.68	.20

Note. *N* = number of observations, *SD* = standard deviation, *SE* = standard error.

Table 5. *Paired Samples* t-*Test Comparing Mathematics Focused Professional Development by Dimension*

Dimension	Paired differences *MD*	*SD*	*SE*	95% CI LB	UB	*t*	*df*	*p*	*d*
Emotional support									
Positive climate pre- vs. post-	.49	1.62	.15	.19	.78	3.27	118	.00	.38
Teacher sensitivity pre- vs. post-	–.33	1.79	.17	–.66	.01	–1.94	112	.05	.23
Student perspectives pre- vs. post-	–.34	1.83	.17	–.67	.00	–2.01	118	.05	.27
Negative climate pre- vs. post-	–.17	1.40	.13	–.42	.09	–1.31	118	.19	.17
Classroom organization									
Behavior management pre- vs. post-	–.58	1.53	.14	–.86	–.30	–4.10	117	.00	.49
Productivity pre- vs. post-	–.64	1.37	.13	–.89	–.40	–5.11	117	.00	.66
Instructional learning pre- vs. post-	–.90	1.68	.15	–1.21	–.59	–5.82	118	.00	.74
Instructional support									
Concept development pre- vs. post-	–.41	2.01	.19	–.78	–.04	–2.21	116	.03	.28
Quality of feedback pre- vs. post-	–.23	1.70	.17	–.55	.10	–1.37	105	.17	.28
Language modeling pre- vs. post-	–.91	2.21	.26	–1.44	–.39	–3.46	.69	.00	.62

Note. *MD* = Mean Difference, *SD* = Standard Deviation, *SE* = Standard Error, CI = Confidence Interval, LB = Lower Bound, UB = Upper Bound, *d* = Cohen's *d*.

Conclusions

The results revealed an immediate impact on early childhood classroom quality after 2 years of professional development delivered in tandem with instructional coaching. Specifically, the data demonstrated that in two major domains—classroom organization and instructional support—there was a noted increase in classroom quality. Classroom organization demonstrated the most significant improvement. Within classroom organization, the results indicated moderate effect in all dimensions, with the largest difference in productivity and instructional learning formats. Unfortunately, the domain of emotional support had no significant improvement. When analyzing the dimensions within the domain of emotional support, the dimension of regard for student perspectives showed significant improvement, but the effect of the improvement was small.

The following null hypotheses guided this study:

1. There is no statistically significant difference between pre- and post-data collection periods of the major domains of classroom quality.
2. There is no statistically significant difference between pre- and post-data collection period within the dimensions of the three major domains of classroom quality.

With respect to the null hypothesis 1, mathematics-focused professional development and instructional coaching had a significant impact on classroom quality. Specifically, the mathematics-focused professional development, delivered in tandem with instructional coaching, had a positive impact on teachers' ability in the major domains of classroom organization and instructional support. With respect to the null hypothesis 2, mathematics-focused ongoing professional development, delivered in tandem with instructional coaching, had a significant positive impact in some dimensions, with the exception of quality feedback, negative climate, and positive climate. Equally important, the results did confirm that the participating teachers demonstrated evidence of change. However, the data revealed that a number of areas remain in need of improvement and may benefit from further professional-development experiences. In general, classroom quality was enhanced; but the design of this study did not capture which particular aspects of the tandem professional development and instructional coaching model effected this change.

Significance and Implications

To meet the challenges of improving young children's acquisition of numeracy skills, professional development designers need to consider ongoing support aimed at the growth and development of in-service teachers. Supporting the learning of teachers is important not only for its own sake, but also because of the impact teacher knowledge has on student learning (Drago-Severson, 2011; Guskey, 2000). Young children have a surprising capacity to learn mathematics; but many children, particularly those in high-needs schools, have a discouraging lack of opportunities to do so. Too many children in high-needs schools not only start behind their peers in more affluent schools, but also begin a negative and immutable trajectory in mathematics with damaging long-term effects. These negative effects are in one of the most important subjects of academic life and also affect children's overall life course (Clements, 2013).

Teaching mathematics effectively needs to be a major focus of in-service professional development programs for early childhood teachers. Professional development experiences need to build teachers' understanding and knowledge of mathematics. When professional development is combined with opportunities for practice, feedback, and in-class coaching, the supports are in place to positively affect classroom practice and eventually student achievement. Programs and curricula designed to facilitate mathematical learning during the early years and continuing through elementary school have a strong positive effect on children's lives for many years thereafter. Starting early with a high-quality mathematics education creates an opportunity for substantial mathematical learning in the primary years that builds on these foundational competencies (Clements, 2013).

Limitations

This particular study explored 2 years of a larger 3-year study focusing on a sample of five small private Catholic elementary schools located in a diverse urban setting. Even though there were a number of positive findings, several limitations need to be acknowledged in relation to this study. First, the number of participants was small and the context was unique. The participants included 26 PreK–3 teachers and seven instructional coaches. The study was limited to PreK–3 teachers and part-time instructional coaches working together in five inner-city Catholic schools. Consequently, readers are cautioned that findings may not generalize to larger, more diverse populations.

Second, the study did not have a control or a comparison group; the sample of participants was not randomly selected. Future work is needed including samples with larger numbers of teachers and coaches. In addition, this small-scale study would need to be further tested in an implementation study, exploring the challenges of implementing a professional development and coaching model with a larger population. The results of the current study, however, may allow others to benefit from what the researchers have learned.

The purpose of the project was to provide professional development and conduct observations as a critical aspect of understanding the level and type of coaching needed. The coaches involved in the project were instrumental in collecting the pre- and post-observation data for this study. Although the collection of data by the project coaches was essential to the project, it was also a limitation that should be noted.

Another limitation that must be noted is the sustainability of this professional development and coaching model in high-needs schools. This particular study was supported by funds from a private grant organization; the continuation of coaching and professional development support is very limited beyond the funding cycle. Additional longitudinal data will be needed to fully understand the impact and sustainability of this tandem professional development and instructional coaching model.

Discussion

Traditionally, considerable resources have been allocated to the type of professional development that is more likely to be focused on knowledge as an outcome in and of itself. Although such efforts could indeed foster more effective practice, the extant evidence suggests it would not (Pianta et al., 2014). In this study, instructional coaching and observed classroom behavior appeared to have mediated subsequent improvements. Confirming prior work on effective professional development (Powell, Diamond, & Burchinal, 2012; Raver et al., 2011), it appears not only that targeted and behaviorally focused professional development, such as coaching or modeling, affects teachers' classroom behavior (Fukkink, 2007), but also that efforts to target and improve behavior can result in changed knowledge and skills such as identification of interactions. This supports professional development models that include instructional coaching and suggests that such job-embedded models of professional development, if designed carefully and aligned with regular workshops, should be integrated into professional development experiences throughout the continuum of early childhood educators' careers (Bredekamp & Goffin, 2012).

The work of teaching young children mathematics needs to be a high priority for early childhood teachers. Teachers of young children need to be supported in their acquisition of acquired competencies and skills throughout the continuum of their careers. This study supports the need to reframe and redesign professional development models. The data suggests that the combination of ongoing professional development and instructional coaching can be an effective design for improving overall classroom quality in mathematics classrooms. The key focus of this study was on the interactions between teachers and students in mathematics teaching and learning experiences. Guiding teachers to examine and improve the various dimensions within the domains of emotional support, classroom organization, and instructional support may be important tools for measuring classroom processes that are linked to more positive student outcomes.

This study suggests that effective professional development models should include not only theory and demonstration but also practice, feedback, and classroom coaching. These results may have some bearing on the current policy and practices related to effective mathematics-focused professional development models for teachers of young children. The results suggest that professional development focusing primarily on building knowledge without models of effective classroom behavior may not be an efficient approach. A better understanding of the professional development models that may influence teachers' development of knowledge and competencies will be an important focus for future research.

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Appendix A
CLASS Observation Instrument

The Classroom Assessment Scoring System™ (CLASS™) is an observational instrument developed at the Curry School Center for Advanced Study of Teaching and Learning to assess classroom quality in PK-12 classrooms. Published in 2007, the CLASS observational protocol is based on over 10 years of educational and developmental research demonstrating that daily interactions between teachers and students are central to students' academic and social development.

The protocol is divided into three domains (emotional support, classroom organization, instructional support) that are further broken down into specific dimensions. The CLASS observation tool assesses the extent to which teachers effectively support children's social and academic development.

CLASS is organized to assess three broad domains of interactions among teachers and children. Each domain includes several dimensions, some of which vary by grade level.

Observable indicators define each dimension. Observation scoring is based on a 7-point scale; scores are assigned based on alignment with anchor descriptions at “high,” “mid,” and “low.”

Across grade levels, the CLASS focuses on the effectiveness of classroom interactional processes rather than on the content of the physical environment, materials or curriculum. For more information on the CLASS, its history or its developers, see Teachstone website (www.teachstone.org).

Domain: Emotional Support

Dimensions:

- *Positive Climate*—the emotional connection between teacher and students.
- *Negative Climate*—the level of negativity (anger, frustration, etc.) exhibited by teachers and/or students.
- *Teacher Sensitivity*—teachers’ awareness of and responding to students’ concerns (academic or emotional).
- *Regard for Student Perspectives*—the degree to which teachers’ interactions with students and classroom activities place an emphasis on students’ interests.

Domain: Classroom Organization

Dimensions:

- *Behavior Management*—how effectively teachers are able to monitor, prevent, and redirect behavior.
- *Productivity*—how well the classroom runs with respect to routines and the degree to which teachers organize activities to maximize student learning.
- *Instructional Learning Formats*—how teachers facilitate activities and provide interesting materials so that students are engaged in learning opportunities.

Domain: Instructional Support

Dimensions:

- *Concept Development*—how teachers use instructional decisions and activities to promote student critical-thinking skills.
- *Quality of Feedback*—how teachers extend students’ learning through their responses to students’ ideas, comments, and feedback.
- *Language Modeling*—the extent to which teachers facilitate and encourage students’ language.

Appendix B

Means and Stability of Fall and Spring CLASS Scores in Preschool Classroom

	Fall	Spring	Correlations	*t*-test
Positive climate	5.07	5.06	.58	.52
Negative climate	1.81	1.71	.38	1.57
Teacher sensitivity	4.46	4.47	.51	– .02
Over-control	2.39	1.89	.29	6.39**
Behavior management	4.76	4.78	.64	– .27
Productivity	4.38	4.39	.46	– .11
Instructional learning formats	4.09	4.12	.53	– .80
Concept development	2.88	2.16	.36	8.57**
Quality of feedback	2.06	1.71	.25	4.40**

**$p < .01$, Taken from Pianta, R., La Paro, K., & Hamre, B. (2008).

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Putting the Pieces Together:
A Model K–12 Teachers' Educational Innovation Implementation Behaviors

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Abstract
The K–12 teacher engagement with educational innovation behavioral elements was understudied. As part of a week-long science, technology, engineering, and mathematics (STEM) education focused professional development program (involving over 600 teachers in year six of implementation), pre and post data were gathered, aligned with educators' consideration of innovative STEM education initiatives, including perceptions of teaching core STEM practices and 21st century skills. Significant correlations among multiple measures motivated creation of a structural equation model using comfort teaching STEM as a proxy for propensity to implement educational innovations. This equation was transformed into a model of teacher behaviors associated with implementing educational innovation.

Key Words
K–12 teacher behavior, professional development, education innovation, educational change, STEM

Introduction

Over the past two decades, a number of large-scale educational reform efforts have been proposed, promoted, and adopted as policy in the United States. These reform efforts include *No Child Left Behind* (Bush, 2001), *Response to Intervention* (for a history of the origin of RTI, see Vaughn & Fuchs, 2003), *Common Core State Standards* (National Governors Association, Center for Best Practices, 2010), and the *Next Generation Science Standards* (NGSS Lead States, 2013). Other educational modification trends have been motivated by widespread popularity or at the local level by community preferences (e.g., the creation and support of STEM schools, one-to-one device initiatives, and charter schools). Yet the efforts to reform education seem to have had little influence on teacher practice, as many of the K–12 schools and classrooms visited by the present researchers reflected traditional curricular content and instructional approaches. However, some teachers were observed and some schools were visited that reflected high levels of educational innovation adoption. The observed variations in the practices of teachers who had adopted educational innovations compared to teachers maintaining a more traditional approach led the present authors to wonder why some teachers were more likely to adopt educational innovations. Further, it was wondered if certain behaviors might be indicators of a higher likelihood of engaging in educational innovation practices that could be used to predict teacher propensity to adopt innovation.

The present researchers were motivated to examine the elements associated with teacher consideration and embrace of educational innovation by their five years of experience leading a large-scale professional development (PD) program for K–12 educators, focused on fostering innovative approaches to teaching and learning using integrated STEM as the content and context. This program has included yearly themes of educational innovation such as inquiry, engineering design, place-based learning, and STEM integrated curriculum. The goal of this PD has been to inspire, energize, and equip the participating K–12 educators to apply what they experienced in the PD by implementing innovative educational practices, ideas, and processes in their schools. Stressed throughout the PD was the expectation that the attending K–12 educators could use the knowledge and experience with educational innovations experienced in the PD to excite and engage their students, their colleagues, and stakeholders in the community by promoting new approaches to STEM teaching and learning.

The present researchers received positive feedback from the attending K–12 educators regarding this PD program. Some of the teachers shared that attending this PD was transformative for them, leading them to make substantial changes in their practice and shift their curricular choices—processes reflective of the adoption of educational innovations. The stories of transformation and adoption of educational innovation caused these authors to wonder what is unique about these teachers that led them to be more likely to adopt educational innovations. One observation was that these teachers tended to have high levels of comfort with teaching STEM.

Considering the potential for STEM education to require innovative approaches to teaching and learning, it was postulated that comfort in teaching integrated STEM was representative of a general comfort with educational innovation and, therefore, a proxy for adoption of educational innovation. Given the present authors' recognition of comfort with teaching STEM to be a potential proxy for engagement in educational innovation, it was seen as beneficial to empirically verify any associated variables. Of particular interest were teachers' professional behaviors associated with educational engagement and innovation implementation—a current gap in the research (Thurlings, Evers, & Vermeulen, 2014). Thus, the primary goal of the present research was to determine what professional behaviors were associated with teacher consideration and adoption of educational innovation using integrated STEM teaching and learning as a proxy for educational innovation. Further, the researchers were interested in knowing if their professional development (PD) program influenced the variables that had been determined to be associated with propensity to engage in and adopt educational innovation. The goal was to empirically document teachers' professional behaviors associated with comfort in teaching STEM and translate the results into a general model of teachers' propensity to engage in and adopt education innovations.

Review of Literature

Teacher Innovation Adoption

While the promotion and adoption of educational reform initiatives frequently requires the implementation of educational innovations, there is a dearth of models depicting the elements influencing teacher consideration of (i.e., thinking about or pondering the idea) and engagement in educational innovations (i.e., actually implementing curriculum and instruction aligned with the innovation) (Thurlings et al., 2014). Complex educational reform initiatives such as those associated with STEM education, particularly teaching and learning integrated STEM, commonly require shifts in curriculum, instruction, content knowledge, roles, practices, and content integration (Honey, Pearson & Schweingruber, 2014). While there has been some research on teacher concerns about implementing complex large-scale reform efforts (van den Berg, Sleegers, Geijsel, & Vandenberghe, 2000), most research on teacher consideration and adoption of educational innovations has focused on specific instructional innovations such as cooperative learning (Ghaith & Yaghi,1997; Guskey, 1988; Metzler, Lund, & Gurvitch, 2008), the use of instructional technology (Donovan, Hartley, & Strudler, 2007; Kebritchi, 2010; Moersch, 1995), or conditions influencing the implementation external to teachers, such as policy changes (Beets et al., 2008; Peers, Diezmann, & Watters, 2003). Thus, there is a gap in the literature in terms of models illuminating the variables associated with teachers' perceptions, considerations, and engagement in implementing educational innovations of their choice (e.g., teaching integrated STEM).

Research on the elements that influence teacher consideration and adoption of educational innovation has revealed a combination of internal and external factors (Rutter & Jacobson, 1986). Of interest in the present study were the elements internal to teachers associated with their propensity to engage with educational innovations. While likely many possible teacher-level variables are associated with their engagement with educational innovation, the currently recognized variables include teacher professional efficacy, professional self-concept, and professional attitudes (Ghaith & Yaghi 1997; Guskey, 1988; Nie, Tan, Liau, Lau, & Chua, 2013), teacher concerns about professional effectiveness and requirements to change their professional practice (Donovan et al., 2007), teacher content and concept knowledge (Lloyd & Wilson, 1998), and perceptions of potential ease and benefit of innovation integration (Morris, 1985). Yet, even with the documentation of these factors, Thurlings et al. (2014) argued that there is a need to further study the behaviors or practices of teachers that are associated with their propensity to adopt and implement educational innovation. Thurlings et al. maintained there is a need to explore the relationships between factors and the potential mediating or indirect effects, a need to examine the factors longitudinally, and a need to examine the factors in structural equation models. Thus, it was determined by the present researchers that there was warrant and justification for examining the relationships between the multiple factors influencing the propensity for teachers to engage in STEM teaching and learning (as documented by their level of comfort in teaching STEM). Further, the present researchers responded to the call for empirically supported models representative of indicators of teacher propensity to engage in educational innovations.

Teacher Change

It was maintained by the present authors that teacher professional engagement was fundamental to their consideration and adoption of educational innovations, and therefore there was justification for exploring issues of teacher professional engagement. In their examination of the variables influencing teacher professional engagement, Rutter and Jacobson (1986) reported on the factors that have "direct effects on teacher engagement" (p. 16). The factors fell into three vectors, focused on teacher, school, and organizational-level influences. While the influence of school and organization variables on teacher professional engagement was acknowledged, the focus of the present research was on the teacher-level variables, and therefore the relationship was explored among teacher level variables that were potentially associated with teacher engagement.

According to Rutter and Jacobson (1986), variations in the teacher engagement vector are associated with such elements as teacher capacity, attitudes, and preparation. Further supporting the justification for focusing on teacher-level variables associated with professional engagement was the potential for professional development to lead to changes in the elements intrinsic to teacher professional engagement associated with their propensity to adopt educational innovations (Borko, 2004; Guskey, 2002; Lumpe, Czerniak, Haney, & Beltyukova, 2012). Further, it was argued that focusing on the variables internal to teachers associated with adopting and sustaining educational innovation were more readily altered compared to schools or organizational-level teacher-engagement variables, which are more complex and therefore involve a long-term process of change (Coburn, 2003; Levine, 1999; McDerrmott, 2000; Simpson, 1990).

As the present authors considered Rutter and Jacobson's (1986) professional engagement factors, it was determined that teachers engaging in integrated STEM teaching were likely to have a higher propensity for adopting educational innovations. Because of the complexity of integrated STEM teaching and learning, many teachers may benefit from participation in professional development designed to reinforce professional behaviors associated with implementing educational innovation (Nadelson, Callahan, Pyke, & Schrader, 2009; Nadelson, Seifert, & Chang, 2013; Nadelson, Seifert, & Hendricks, 2015; Nadelson, Seifert, & Hettinger, 2012; Nadelson, Seifert, & McKinney, 2014). Thus, there was justification for identifying the professional behaviors associated with teacher propensity to shift their practice and engage in educational innovations.

Knowledge Seeking by Teachers

The present authors maintained that a fundamental factor associated with increasing teacher propensity to engage in educational innovations was ongoing learning. There is an expectation that K–12 teachers will take a reflective approach to their practice and seek ways of being more effective at engaging their students and offering progressive curriculum and instruction (Loughran, 2002). One potential way K–12 educators can enhance their effectiveness for implementing educational innovation is to engage in professional development opportunities designed to increase knowledge of and comfort with STEM content, curriculum, and instruction (Antoniou & Kyriakides, 2011). The present authors considered teacher voluntary engagement in professional development to be an indicator of their knowledge seeking (and professional engagement) that was likely related to their desire to increase their professional effectiveness (Richter, Kunter, Klusmann, Lüdtke, & Baumert, 2011). Thus, it was argued that teachers who voluntary engaged in the present researchers' integrated STEM teaching and learning professional development programs were intrinsically seeking the knowledge necessary to effectively teach integrated STEM, an educational innovation. Given that teacher knowledge is one of the elements Rutter and Jacobson (1986) considered critical to teacher engagement, it was maintained that teacher involvement in professional development was a potential indicator of willingness to consider and adopt educational innovations.

Teachers' Sense of Responsibility

While teacher leadership has been documented in relationship to educational innovation adoption (Kim & Kim, 2013), it was argued by the present researchers that it is teachers' sense of responsibility that motivates them to take ownership of the curriculum, their instruction, and their willingness to lead by example. When teachers assume responsibility for the learning of their students, they are likely to have a higher level of efficacy for teaching (Ross & Gray, 2006). Similarly, when teachers assume the responsibility for examining and guiding curricular choices and instructional approaches, they are likely to be more reflective in their practice (Inel, McManus, Palmer, & Panarese, 2014). Further, by assuming a sense of responsibility, such as a leadership role within faculty (e.g., committee chair, level leader, or department chair), teachers position themselves in situations that expose them to a range of views and conditions which require understanding the multiple facets, complexity, and benefits of implementing innovations (Guiney, 2001).

The present researchers maintained that when teachers assume a sense of responsibility for their profession, they may also be developing levels of professional efficacy, leadership capacity, professional reflection, and educational system awareness—all factors that are arguably associated with propensity to successfully adopt educational innovations. Thus, there was justification for the present researchers' position that teacher sense of professional responsibility was an element of teacher professional engagement that was critical to their propensity to adopt educational innovation.

Embracing Change

Teachers' consideration and implementation of new curriculum and instruction requires them to move beyond openness to change to actually embracing the change (Larrivee, 2000). While open-minded thinking is associated with the potential recognition or consideration of change, engaging in a level of thinking about a new idea as a possibility is a critical step toward the actual educational innovation implementation (Elik, Wiener, & Corkum, 2010). Thus, teachers who embrace change are likely to be more comfortable experimenting with their instruction and are willing to take risks associated with teaching new curriculum (Darling-Hammond & Richardson, 2009). The present researchers posited that teachers who embraced change were likely to have higher levels of comfort with ambiguity and risk taking; and therefore, a potential predictor of teachers who were likely to implement innovations was the level to which they embraced educational innovations.

Exploring Opportunities

It was argued that teacher willingness, desire, and engagement in the exploration of curricular and instructional opportunities was an expression of their sense of curiosity. Acting on their curiosity by exploring curricular and instructional opportunities may lead teachers to be better prepared and more motivated to adopt and implement educational innovations (Hansson & Pesämaa, 2012). Similarly, when teachers explore new curricular and instructional opportunities, they are likely more open to engaging in novel teaching and learning situations, or more eager to pursue professional challenges (Huberman, 1989). It is also possible that teachers' engagement in the exploration of professional opportunities is an expression of a desire to find instructional approaches or innovative practices that increase their effectiveness for optimizing student learning (Dixon, 2012). It was argued by the present researchers that teacher propensity to explore instructional and curricular opportunities was related to their propensity to consider and actually implement innovation. Thus, a model of teacher behaviors associated with implementing innovation should take teacher exploration of curricular and instructional opportunities into consideration.

Professional Development to Foster Implementing Innovation

Professional development can increase teacher propensity to consider, adopt, and implement an educational innovation (Abrami, Poulsen, & Chambers, 2004; Frost, 2012). Highly effective professional development actively engages teachers in reflection on their practice, increases teachers' leadership skills, and provides a vision of adopting and supporting change in their schools (Garet, Porter, Desimone, Birman, & Yoon, 2001). Therefore, there was justification for positing that PD could facilitate teacher consideration, adoption, and implementation of innovation. Professional development can be transformative for teachers by providing them the tools, resources, content, and models to empower them to make changes to their practice and motivating them to promote change in their schools and with their colleagues (Poekert, 2012). Given the potential influence of teacher engagement in PD on their capacity to embrace change and interest innovation implementation, there was justification for including PD engagement as a potential indicator of teacher propensity for implementation of educational innovation.

STEM and a Propensity for Implementing Innovation

The extent to which teachers engaged in promoting and teaching integrated STEM was perceived to be a context for examining teacher propensity to implement educational innovation in general. Thus, measures of teachers' promotion and engagement in integrated STEM would be likely predicted by the levels of their sense of professional responsibility, engagement in knowledge seeking, embrace of educational change, and desire to explore instructional and curricular opportunities. The present researchers considered comfort with teaching STEM to be aligned with a general propensity of teachers to consider and adopt educational innovation, as comfort is associated with openness to consider, and perhaps engage in educational innovations. Thus, it was determined that the outcomes of the following measures were likely predictors of comfort with teaching integrated STEM and could be proxies of the general propensity of teachers to adopt and implement educational innovations:

- Participation in the STEM education professional development
- Knowledge of and engagement with core STEM practices
- Promotion of STEM education in the community
- Perceptions of place-based STEM education
- Integration of instructional technology for teaching
- Teaching of 21st century skills

Method

The goal of the present research was to determine (a) which variables were related to teacher comfort with teaching integrated STEM, an indicator for considering and implementing educational innovations, and (b) which variables were associated with comfort in teaching integrated STEM. From the findings, it was sought to develop and propose a model for teacher consideration, adoption, and implementation of educational innovation in general. To guide this research, the following questions were used:

- What is the relationship among teachers' STEM related knowledge, perceptions, and practices and their comfort with teaching STEM?
- When considered simultaneously, which variables are most predictive of comfort of teaching integrated STEM?
- How did this professional development program influence the knowledge, perceptions, engagement, and practices of the program participants?

Participants

All participants were K–12 educators who voluntarily registered for a summer professional development institute and were from the same state in the western United States. Over 500 teachers participated in this summer institute; however, the pre and post institute survey data were able to be matched for only 347 participants. Thus, the sample consisted of 347 K–12 educators who were on average 43.59 years old (*SD* = 10.34) and had worked in K–12 education for an average of 12.90 years (*SD* = 8.79). The participants consisted of approximately 57% elementary teachers, 27% middle school teachers, and 16% high school teachers, and 80.2% were female. The teachers reported an average level of comfort in teaching integrated STEM of

5.49 ($SD = 2.34$), which, being on a 10-point scale, suggested a moderate level of comfort. The participants also reported a moderate level of engagement in promoting STEM education in their communities ($M = 5.01$, $SD = 2.52$). Of the 347 participants, approximately 44.4% had participated in one of the present researchers' prior STEM PD institutes.

The Summer Institute

The STEM summer institute program was designed to use a combination of approaches to providing PD focused on core STEM practices (Nadelson et al., 2015), use of instructional technology, integrated STEM (Nadelson et al., 2014), place-based STEM (Nadelson et al., 2013) and 21st century skills (Dede, 2010). The goal of this intensive four-day summer PD institute was to enhance teacher leadership, pedagogical knowledge, instructional effectiveness, and awareness of the many ways of teaching integrated STEM content. The present researchers had been offering and refining the summer institute for six years. The institute provided about 45 hours of direct contact time, 20–25 hours of which was dedicated to learning integrated STEM content in *strands*—courses developed around integrated regional STEM content (e.g., energy, robotics, agriculture, forestry, health, aerospace, and mining) that leverage local resources and include business and industry partners. Each strand had about 15–20 enrolled participants.

Strands were selected from the pool of applications submitted by individuals or groups entering the competitive consideration to be invited to provide a strand at the summer institute. The annual competition to present ensures that strands are relevant, adhere to current state and national learning standards and practices, and provide quality professional development. Interested individuals or groups submitted strand applications that included a syllabus, lesson plans, details of how their strand was aligned to current STEM learning standards and practices, how they would integrate a digital camera into their strand instruction, and a material list for a classroom "kit" of up to $250 of instruction supplies for each of the 15–20 participants required to implement their strand curriculum. The selected strand leaders developed and submitted a strand content/subject-aligned knowledge test of integrated STEM concepts which were vetted and modified for clarity. The strand providers used the content/subject assessment to pre- and post-test the strand-related content knowledge of their participants.

The strand leaders taught their integrated STEM curriculum modeling best instructional practices and educational innovations. Participants engaged in laboratory experiments, independent projects, research activities, field trips, alternative assessments, and presentations. Each participant was expected to create an integrated STEM lesson idea (a mini lesson or unit plan based on a template provided by the present researchers) aligned with STEM learning standards.

The balance of the institute time (approximately 15–20 hours) was dedicated to plenary sessions, group STEM education activities (e.g., family engineering), planning, and participant lesson sharing. Three of the plenary sessions were presentations by keynote speakers who discussed and explored a range of STEM education topics and addressed issues related to teaching core STEM practices, integrating STEM, the value of place-based learning, and the necessity of student development of 21st century skills, and teachers as innovators. During the planning sessions, it was emphasized that the participants use the time to develop approaches and timelines for engaging their students, colleagues, and community in a range of innovative and integrated STEM learning opportunities.

Measures

The present research team collaborated on the development of the surveys that were used in the investigation. To gather participants' professional characteristics, a demographic survey was used that the research team had been refining over five years. The team also developed four additional instruments composed of combinations of selected and free-response items to gather an array of other innovative practices and integrated STEM-education–related information. The first survey assessed the participants' knowledge, perceptions, and engagement with core STEM practices. The second survey assessed the participants' instructional use of technology. The third survey assessed the participants' engagement and knowledge of place-based STEM. The fourth survey assessed the participants' knowledge and teaching of 21st century skills. For the present report, data from the core STEM practices survey and the demographics survey were used.

Demographics. The research team developed a demographic survey using standard items of age, highest degree attained, years of teaching experience, teaching endorsements, current employment position, and sex. Participants were asked how many prior STEM summer institutes they had attended (the range was 0 to 4). An item was included asking participants to rate their comfort with teaching integrated STEM, on a scale from 1 ("Very Uncomfortable") to 10 ("Very Comfortable"). An item was also included asking teachers to rate the level to which they were engaged in promoting STEM in the community, on a scale from 1 ("No Engagement") to 10 ("Extremely Engaged"). Both of these single 10-point scale items were analyzed in previous research by comparing outcomes to multiple item measures assessing the same constructs. A high level of correlation was found between the single-item response and the composite score of the multiple-item measures (above r = .80), so the team felt justified in using these single-item measures to assess the K–12 educators' comfort in teaching integrated STEM and engagement with promoting STEM in the community. Over the five years of this project, the demographic measure has yielded consistent data.

Core STEM practice. The research team choose to frame the core STEM practices survey around the Next Generation Science Standards (NGSS) and Common Core State Standards–Mathematics (CCSS–Math) practices. It was anticipated that the participating K–12 educators would have limited knowledge of core STEM practices beyond math and science, and even more constrained knowledge of the authentic practices of STEM professionals. Further, it was expected that the teachers who taught core STEM practices would be most likely to be able to relate to the NGSS and CCSS–Math practices and, therefore, would find NGSS and CCSS–Math practices–related questions relevant and attainable. The NGSS and CCSS–Math practices were chosen to use as a frame because the STEM standards' practices are fundamental to the preparation and work of engineers and other STEM professionals.

Several free-response items were created to gather the participants' knowledge of the practice data, using prompts such as "In your own words define the 'practices' of the CCSS–math," and "How do you assess your students' development of CCSS–Math practices?" These items were repeated using NGSS in place of CCSS–Math. Several Likert-like 5- and 10-point scale items were created to assess participants' perceptions of the practices, which included such items as, "Rate the confidence in your ability to effectively integrate the CCSS–Math practices with the science content you teach," and "We discuss the CCSS–Math practices in faculty meetings." The items were repeated with NGSS in place of CCSS–Math. The 22 items in the practices survey were evenly divided between CCSS–Math and NGSS practices. The research team's reliability calculation of the 12 selected response items produced a Cronbach's alpha of .82, indicating a good level of reliability.

Technology engagement. To assess our participants' perceptions and engagement with instructional technology, particularly for teaching math and science, we adopted and the modified the TPACK survey (Schmidt et al., 2009–2010). The version of the TPACK survey we used contained 46 items aligned with inservice teacher practice. The survey contained seven subscales with internal consistency values ranging from .75 to .92. The TPACK instrument contained items such as, "I frequently experiment with instructional technologies in my teaching," and "I use instructional technology to foster my students' mathematical thinking," which were answered on a 5 point Likert scale. We modified the instrument by eliminating the items that were not STEM aligned (e.g. social studies focus) reducing the number of items on the survey from 46 to 32. Schmidt et al. (2009–2010) reported an overall reliability of .95. Our reliability analysis revealed a Cronbach's alpha of .96, which is consistent with prior research and suggests a high level of instrument reliability.

Place-based STEM teaching. To assess the participants' place-based STEM practices, the prior instrument was enhanced (Nadelson et al., 2013) to contain a combination of selected and free-response items. The team had been working this instrument to assess the impact of its place-based STEM focus for 3 years. Thus, the team's approach was considered to be an ongoing exploration into place-based STEM, which has helped the team to refine its methods for gathering data regarding teacher knowledge and engagement in place-based STEM.

To gather data to determine how and to what extent the participants engaged in place-based STEM curriculum development, instruction, and collaboration, six free-response items were developed, such as "Who in your community is the most instrumental in advocating student STEM learning?" and "What kind of relationships exist between your community and school in regards to STEM education?" The team's previous place-based survey responses were used to develop a series of selected response items to assess the participating K–12 teachers' place-based STEM practices.

These items were vetted with faculty and researchers familiar with the practices associated with place-based learning. Based on their feedback, small modifications were made to the language of the instrument, but it retained the initial content and emphases. The 12 selected response items included such statements as, "Rate the level to which you use local resources outside the school to teach STEM," which were answered on a 10-point Likert-like scale. Items such as, "My students are more interested in learning STEM when I use place-based resources" were answered on a 5-point Likert-like scale. The Cronbach's alpha was calculated to be .91, which indicated a good level of reliability of these 12 selected response items.

21st century skills. Similar to place-based STEM, the research team had been examining teacher knowledge and instruction of 21st century skills for three years. Based on research, the team had found a wide range of teachers' knowledge, but consistently low levels of explicit teaching of the skills. The team's two rounds of qualitative responses were used to design a series of 5-point Likert-like scale items and 10-point Likert-like scale items. Thus, it was sought to gain a deeper understanding of how teachers might be explicitly or implicitly teaching 21st century skills. Such items were generated as, "Rate your confidence in your ability to foster your students' development of 21st century skills" to be answered on a 10-point Likert-like scale ranging from 1 ("No Confidence") to 10 ("Extremely Confident") and such items as, "Modeling 21st century skills is a fundamental aspect of my instruction," which was answered on a standard 5-point

Likert-like scale. The items were vetted with several education researchers who also focused on 21st century skills and, based on their feedback, minor adjustments were made to instrument. The final instrument contained 20 selected-response items, which had a Cronbach’s alpha of .93, indicating a high level of reliability. One free-response item was also included that asked the participants to define 21st century skills.

Data Collection

A repeated measures design was used to survey participants before the summer institute and again after the institute. The K–12 educators who voluntarily registered for the institute were emailed a link to these surveys and were instructed to complete the survey prior to attending the summer institute, and to print a confirmation page indicating completion to bring with them and submit at registration. Those who did not have the form and did not complete the surveys did so at the time of registration. At the end of the institute, another email was sent to all participants with a link to the post-institute survey, and participants were given 3 weeks to complete the survey.

All data collection was anonymous, so the participants were asked to select a five-digit phone code (the last five digits of any phone number) that they would easily recall and use in the surveys so that the researchers could pair the pre and post survey data and the pre and post content knowledge test data. Data collection took place on line using SurveyMonkey.

Results

Related Variables

The first research question asked, “What is the relationship among teachers’ STEM related knowledge, perceptions, and practices and their comfort with teaching integrated STEM?” To answer this question, a correlational analysis was conducted of the teachers’ comfort in teaching integrated STEM and the composite scores on the measures of engagement in core STEM practices, place-based STEM, use of instructional technology, and teaching 21st century skills. Also included in the analysis were the number of times that the participants had attended one of the summer institutes, and levels of promoting STEM education in their communities.

The analysis revealed that all of the measures were significantly positively correlated with comfort in teaching integrated STEM, such that as their level of comfort teaching STEM increased, the levels of the other measures also increased (see Table 1). This analysis suggests that all of the measures were related to comfort in teaching integrated STEM. Based on these data, the research team proceeded by examining how the measures were related to comfort in teaching integrated STEM when considered simultaneously in a structural equation model.

Considered Simultaneously

The second research question asked, “When considered simultaneously, which variables are most predictive of comfort teaching STEM?” To answer this question we conducted a structural equation model analysis, using a path model design. We began our analysis by including all of our measures as predictors (independent variables) of comfort teaching integrated STEM (dependent variable and proxy for engaging in educational innovation). We correlated all variables and set the error for comfort to 1. Our analysis revealed a low alignment between the data and model with statistical indicators suggesting a poor fit, with CFI = .50, NFI = .50 and

RSMEA = .29. Our examination of the estimates revealed that when considered with our other measures knowledge and teaching of place based STEM and of 21st century skills were not predictors of comfort teaching STEM s (see Table 2).

Table 1. *Correlations among STEM Knowledge, Perceptions, and Practices and Comfort in Teaching Integrated STEM*

	Comfort teaching STEM	**Engage in STEM PD**	**Promoting STEM**	**Core STEM practices**	**Place-based STEM**	**Use of instructional tech**	**Teaching 21st century skills**
Comfort teaching STEM	--	.39**	.57**	.45**	.41**	.34**	.38**
Engage in STEM PD		--	.24**	.07	.17**	.07	.21**
Promoting STEM			--	.36**	.42**	.24**	.32**
Core STEM practices				--	.54**	.40**	.44**
Place-based STEM					--	.40**	.48**
Use of instruct tech						--	.47**
Teaching 21st century skills							--

*$p < .05$ **$p < 0.01$ level, 2-tailed

Considered Simultaneously

The second research question asked, "When considered simultaneously, which variables are most predictive of comfort teaching STEM?" To answer this question a structural equation model analysis was conducted, using a path model design. The analysis was begun by including all of the measures as predictors (independent variables) of comfort in teaching integrated STEM (dependent variable and proxy for engaging in educational innovation). All variables were correlated, and the error for comfort was set to 1. The analysis revealed a low alignment between the data and model with statistical indicators, suggesting a poor fit, with CFI = .50, NFI = .50, and RSMEA = .29. An examination of the estimates revealed that when considered with the other measures, knowledge and teaching of place-based STEM and of 21st century skills were not predictors of comfort in teaching STEM (see Table 2).

Table 2. *Estimates for the Initial Path Model*

Predictor (independent variables)	**Estimate**	**Sig. (*p* value)**
Knowledge, perceptions and engagement in core STEM practices	.219	.000
Use of instructional technology	.098	.031
Engaging in STEM PD	.202	.000
Engaging in promoting STEM in the community	.420	.000
Knowledge and teaching of place-based STEM	.033	.420
Knowledge and teaching of 21st century skills	.061	.144

Revised Model

Based on the outcome of the initial path model, the non-significant predictors of comfort in teaching integrated STEM were removed, and a new path model was created for the structural equation analysis. This analysis revealed that the remaining variables were all significant predictors of comfort in teaching integrated STEM (see Table 3). The correlations among the independent variables were examined for significance, the non-significant correlations were eliminated, and the analysis was run again. The results of the analysis revealed $\chi^2(2, N = 347) = 2.38$, $p = .31$, failing to reject the null, indicating that the model fit the data. Further confirmation for the model's fitting the data was the comparative-fit index value above .95 (CFI = .997), the normed-fit index value also above .95 (NFI = .993), and a root mean square error of approximation below .05 (RMSEA = .023), which were indicators of effective model fit (Byrne, 2010).

Table 3: *Estimates of the Predictor Variables for the Revised Model*

Predictor Variables	**Estimate**	**Sig. (*p* value)**
Engaging in STEM PD	.27	.000
Engaging in Promoting STEM in the Community	.39	.000
Knowledge, Perceptions and Engagement in Core STEM Practices	.24	.000
Use of Instructional Technology	.13	.003

The fit between the research team's data and the model indicated that the predictor variables could account for about 46% of the variance of comfort in teaching integrated STEM, the dependent variable. Thus, it appeared that seeking professional development, promoting STEM education in the local community, levels of knowledge and perceptions of core STEM practices, and use and engagement with instructional technology effectively predicted almost half of the variance of the level of comfort in teaching integrated STEM (see Figure 1).

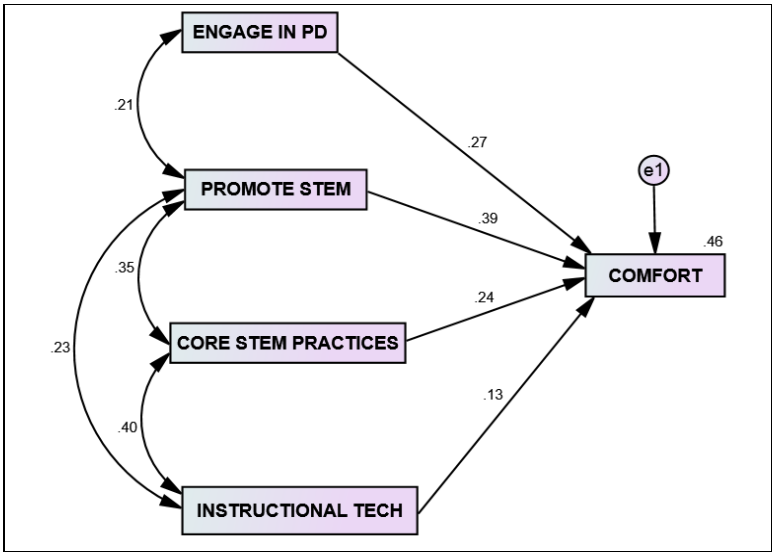

Figure 1. Path model for comfort in teaching STEM.

Change with Professional Development

The third research question asked, "How did our professional development influence the knowledge, perceptions, engagement, and practices of our participants?" To answer this question, the research team compared the pre and post professional development responses of the participants to the measures using a paired-samples *t*-test. The analysis revealed significant positive gains ($p < .000$) for all of the measures (see Table 4). The largest gain was for knowledge, perceptions, and engagement with core STEM practices (Cohen's $d = 1.00$), while the lowest gain was for engaging in promoting STEM in the community (Cohen's $d = .24$). Regardless, the analysis revealed that the professional development institute had a moderate to large effect on the measures of teacher knowledge, perceptions, and engagement with integrated STEM education.

A Proposed Model

Based on the research team's data and structural equation model, a model representative is proposed of the teacher behaviors associated with the consideration and implementation of innovations. Given the potential for educational innovations to be highly contextual (Findlow, 2008), it is anticipated that there are likely to be variations in teacher engagement in educational innovations based upon who is motivating of the innovation, the alignment with the teacher's

Table 4: *Pre- and Post-Measure Means, Standard Deviations,* t-*Statistic, and Effect Sizes*

Variable	Premeasure means (*SD*)	Post-measure means (*SD*)	*t*	Effect (*d*)
Comfort teaching integrated STEM	5.49 (2.33)	6.78 (1.94)	12.59**	.60
Promoting STEM in the community	5.01 (2.52)	5.60 (2.31)	4.57**	.24
Engagement with core STEM practices	42.80 (13.06)	56.26 (13.97)	21.05**	1.00
Knowledge and teaching place-based STEM	35.87 (15.28)	50.70 (17.76)	20.19**	.90
Teaching using instructional technology	3.50 (.55)	3.77 (.52)	12.20**	.50
Knowledge and teaching 21st century skills	3.25 (.97)	3.77 (.95)	11.49**	.54

** $p < .01$

local culture or community, and the expected level of conformity for the teachers. Yet, as focus is placed upon teacher vector associated with engagement (Rutter & Jacobson, 1986), the research team considers its path model to be representative of the general extent to which teachers may consider and implement educational innovations. Based on the team's assumption that teacher comfort with teaching integrated STEM is a proxy for their propensity to engage in educational innovations in general, the team began to interpret the four predictive variables in the proposed path model (see Figure 1). It was argued that each of the predictive variables were representative of behaviors associated with teacher engagement in educational innovations (see Figure 2). The four behavioral elements that were posited to be associated with teacher propensity to engage in educational innovations were knowledge seeking, acting on a sense of responsibility, embracing change, and exploring opportunities.

Knowledge Seeking

The first behavioral element predictive of implementing innovation was *knowledge seeking*, which was representative of teachers' active and voluntary seeking of opportunities to formally continue their education and continue to learn. It was assumed that the measure of the number of PD institutes attended or the extent of engagement in PD was aligned with the level of teacher knowledge seeking and a desire to learn more to be more effective and prepared to implement innovation. Thus, it was argued that through the process of knowledge seeking, teachers engaged in a process of learning more as they prepared themselves to successfully implement new ideas, be more creative in their teaching, and be more effective in their practice in general. The desire to continue to learn suggested that teachers were aware of the advantages to continuing their education with regard to being more effective in multiple facets of teaching. Engaging in PD focused on core STEM practices and integrated STEM suggested that teachers were seeking knowledge to effectively teach lessons aligned with the educational innovations associated with STEM. Thus, based on the researchers' data, it was contended that teacher knowledge seeking was a behavior associated with their self-preparation to implement innovation, and therefore was an indicator of propensity to implement innovation.

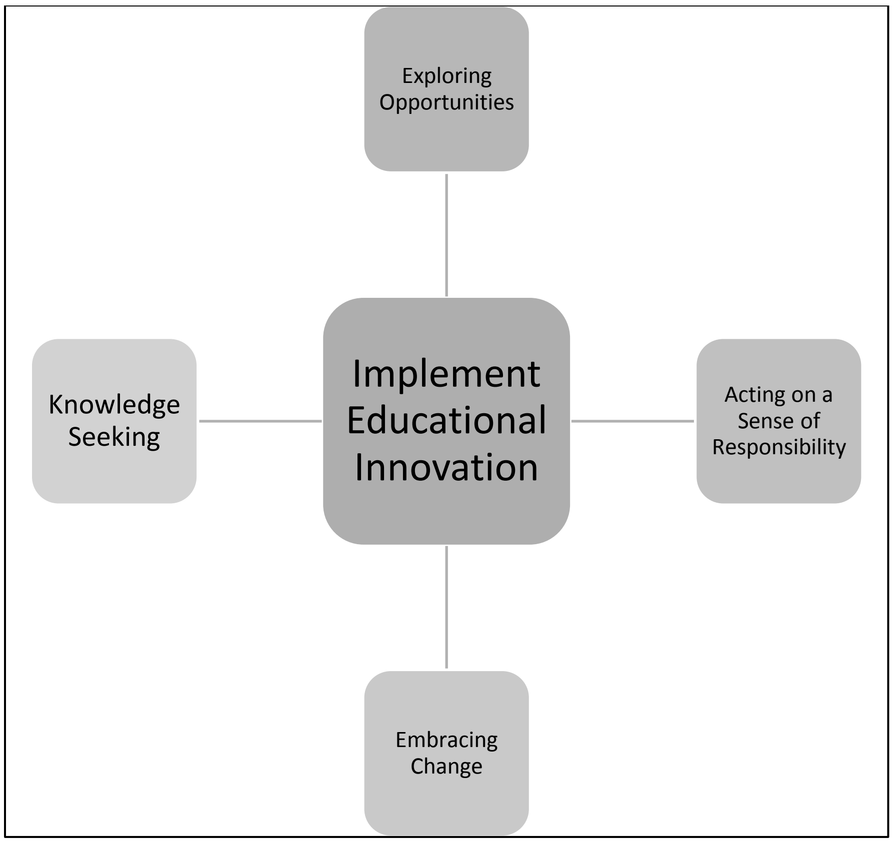

Figure 2. The behavioral elements as indicators of teacher propensity to implement innovation.

Acting on a Sense of Responsibility

The second behavioral element that was posited to be predictive of implementing educational innovations was *acting on a sense of responsibility,* which was representative of the extent to which teachers assumed the responsibly and leadership associated with actively engaging in promoting and communicating educational innovations. It was maintained that the measure of promoting STEM in the community was a proxy for teachers' leading and acting upon the responsibility for supporting and informing others about STEM education as an innovation. Leading and acting upon the responsibility to inform others about educational innovations reflected a teacher's commitment to the innovation, knowledge of the innovation, and a personal desire to support and validate the innovation. Also, by promoting educational innovations in their community, teachers were sharing their perceptions of the importance of innovation to education.

It was contended that the behavior of leading and acting on a sense of responsibility for educational innovation was reflective of teacher perceptions of the innovation's having utility and value. Thus, it was argued that teachers who promoted innovation were more likely to engage in the behaviors associated with leadership and commitment to innovation implementation. Based on the present analysis, it was maintained that the level of teachers' sense of responsibility was related to commitment to implementing educational innovations and, therefore, was an indicator of their propensity to implement educational innovations.

Embracing Change

The third behavioral element posited to be predictive of implementing innovation was the process of *embracing change*, which was representative of the level to which teachers considered, adopted, and integrated new ideas in their curriculum and instruction. Based on the present analysis, the measure of the teachers' knowledge, perceptions, and engagement of core STEM practices was considered a proxy for the level to which participating teachers embraced change. It was argued that when teachers embraced change and supported an educational innovation, they were likely to be informed about the innovation, find other teachers who were like-minded and supportive of the innovation, and engage with others in attempts to find ways to effectively implement the innovation. The process of embracing change was seen as critical to teachers' process of working to find effective ways to transition their curricular choices and instructional approach to better align with the educational innovation. Based on the data, it was maintained that teachers who embraced change may have been more open minded to educational innovations, and therefore were likely to move beyond the consideration of the innovation to taking actions to implement the innovation. Therefore, it was maintained that the level to which teachers embraced change was an indicator of their propensity to implement educational innovations.

Exploring Opportunities

The fourth behavioral element posited to be predictive of implementing educational innovations was *exploring opportunities*, which it was argued was representative of the level to which teachers explored, experimented with, and reflected on educational innovation implementations. The assessment of the teachers' perceptions and use of instructional technology to teach was considered a proxy for the levels to which they were willing to explore educational opportunities. It was reasoned that teachers who were willing to explore educational opportunities were more likely to take the risks associated with educational innovation implementation, reflect on the outcome of the implementation, and refine their approach to optimize the benefit of the innovation to increase their teaching effectiveness and their students' learning. Because of the possibility that teachers who were willing to explore educational opportunities were likely to assess the risks and benefits on an innovation through experimenting and reflecting, it was argued that the level of teacher exploration of opportunities was an indicator of propensity to implement educational innovations.

A Model of Teacher Behaviors and Propensity for Innovation Implementation

The present model of teacher behaviors, actions, and processes in which they engage associated with their propensity to implement educational innovation assumed that the elements interacted and therefore should be considered as a whole. The research team maintained that level of engagement in the behaviors of knowledge seeking, explorating opportunities, acting on a sense of responsibility, and embracing change were indicators of the propensity to which teachers engaged in implementing innovations (see Figure 2). Thus, it was contended that if teacher engagement could be increased in the behaviors associated with implementing educational innovations (e.g., integrated STEM education), then teachers' propensity for implementing the innovations could be increased.

Discussion and Implications

Determining the propensity of K–12 teachers to engage in the consideration and implementation of innovative curricula and instruction involves a combination of elements that are internal and external to the teachers. Variations within individual, school, and community combine to influence the level to which teachers engage in thinking about and actually implementing educational innovations. The multifaceted influences on teacher engagement provided the present researchers with justification for determining the elements of teacher behavior that were predictive of their propensity to adopt innovative curricula and engage in innovative instructional practices. Using integrated STEM teaching and learning as a context for both innovative curriculum and instruction, the research team gathered a range of empirical data to develop a model of teacher behaviors predictive of engagement in implementing educational innovation. Some initial steps were also taken to answer the call by Thurlings et al. (2014) to develop empirically based models of teacher behaviors and practices associated with their propensity to consider and engage in educational innovations.

Knowledge seeking, embracing change, exploring opportunities, and acting on a sense of responsibility were identified as four behaviors that were significant indicators of teacher consideration and engagement in educational innovations. Thus, there was justification for designing professional development that attends to teacher behaviors associated with implementing innovative curriculum and instructional approaches. These elements were attended to in the research team's integrated STEM professional development program and a range of data was gathered to empirically determine the variables associated with comfort in teaching STEM. Since significant gains were found in the measured variables from pre to post professional development, enhanced likelihood was speculated that the participating teachers would engage in implementation of educational innovation behaviors. Thus, it was maintained that, with an appropriately designed and delivered intensive integrated STEM professional development program, there was opportunity to enhance the propensity for teacher innovation implementation behaviors. The most efficient ways of enhancing teachers' education innovation adoption behaviors will be the future direction of the team's research.

An important implication for generating an empirically supported model for the association between teachers' behaviors and their implementation of educational innovations, is the potential for this model to guide the structure and focus of the present authors' integrated STEM professional development model. Structuring professional development to enhance the capacity of teachers to implement educational innovation should attend to and foster the associated behaviors. However, some of the behaviors that were identified in the present model may be very difficult to influence, as the behaviors may be deeply rooted in the individual or may be out of their control and therefore difficult to modify. Regardless, seeking ways to attend to innovation implementation behaviors is needed and likely to be highly useful for assuring effective teacher professional development and support for educational innovation. In addition, it is possible that professional development focused primarily on fostering behaviors that enhance teachers' propensity to adopt innovation, may be a pathway to organizational change as, collectively over time, teacher behaviors may transform the cultural norms and practices of the organization.

A second important implication is the necessity for organizational structures and working environments that are conducive to supporting teacher educational innovation implementation behaviors. Reinforcing and supporting teacher behaviors associated with educational innovation adoption is likely to create a culture of change and increase consideration and implementation of innovations associated with curricular structures and instructional techniques to large-scale initiatives and organizational changes.

A third implication is stressing the importance of attending to educational innovation implementation behaviors as part of pre-service teacher preparation programs. By increasing teachers' awareness of these behaviors early in their careers, as part of their preparation, and increasing their engagement in the behaviors as part of being a reflective practitioner, they will likely be effective agents of change early in and throughout their careers. Refining the processes of acknowledging and supporting implementation behaviors as part of teacher preparation programs is an excellent direction for both program development and research.

Limitations

The first limitation of the present research was the use of proxy assessments rather than explicit measures of the behaviors in the proposed model. The use of surveys was justified, as they were contextualized to STEM teaching and learning and aligned with the focus of the professional development. In future research, the research team plans to be more explicit with regard to the measures of innovation implementation behaviors. Further, there is a need to investigate the domain-general and domain-specific innovation implementation behaviors.

The second limitation was the nature of our sample, all of whom were teachers drawn from the same state and thus were likely to be influenced by state policy, resources, and educational structures. However, the sample was rather large, considering that over 600 teachers attended the summer institute, including 347 whose pre and post-test could be matched. A sample that includes teachers from different locations could reveal different or unique relationships, and therefore would be an excellent direction for future research.

Conclusion

Teacher consideration, adoption, and implementation of educational innovations are complex processes that include individual and organizational factors. The present researchers focused on the individual factors of teacher behaviors associated with implementing innovation using the context of integrated STEM. The proposed model reflected four behaviors associated with and indicative of teacher consideration and implementation of innovation. It is hoped that others will evaluate, test and work with the present researchers to refine this model, as teacher consideration and engagement in implementing educational innovations is a complex process, yet, critical for integrating new initiatives such as integrated STEM and reforming curriculum and instruction in alignment with new research and empirical support.

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Real World Connections: A Case for Integrating Environmental Education into Preservice Teacher Education

Robyn A. Hill

Abstract
Improving environmental literacy is imperative to the wellbeing of children and the planet. This paper makes the case for fully integrating environmental education into preservice teacher education, rather than relegating it to the purview of teacher, school, or district initiatives or to community-based partnerships that may not be able to provide a cohesive and comprehensive approach to the content.

Key Words
Environmental education, environmental literacy, teacher education, sustainability

Introduction

Current trends in education have intensified their focus on the use of technology, as exemplified by government support for improving STEM (science, technology, engineering, mathematics) programs in schools; the use of computers, iPads, and smartboards in classrooms; and the unprecedented growth of online learning. Within broader society, the availability of wireless Internet connectivity, use of smart phones, and the popularity of video games and social media sites are on the rise. Whereas all of these phenomena have positive attributes, there is increasing evidence that the dramatic increase in the use of technology has also had the deleterious effect of significantly decreasing the amount of time people spend outdoors and in natural environments (Juster, Ono, & Stafford, 2004; McCurdy, Winterbottom, Mehta, & Roberts, 2010).

This disconnect from the natural world is particularly detrimental to children and is associated with the prevalence of myopia (Dolgin, 2015; Rose et al., 2008) and an increase in childhood obesity (Kahn & Kellert, 2002; Brody, 2015). In the latter case, not only was lack of activity a factor, but also a lack of knowledge about nutrition and where food actually comes from. In a recent observation at a local nature center, a teacher asked a group of 20 third graders gathered around a large aquarium which creature had no bones, the lobster or the fish. Approximately two thirds of the students asserted that fish have no bones. Though they claimed to eat fish, their experiences were limited to sticks and patties. In the Emmy award winning show *Food Revolution*, Chef Jamie Oliver visited U.S. schools and found that first graders in West Virginia were unable to identify common fruits and vegetables, a phenomenon that has also been demonstrated through other research (Bissell, 2013; Dollahite, Hosig, White, Rodibaugh, & Holmes, 1998; Moss, Smith, Null, Long Roth, & Tragoudas, 2013).

On the opposite end of the spectrum, recent research has shown that learning outdoors, spending more time in natural environments, having proximity to green spaces, and engaging in outdoor activities can improve focus and attentiveness (Fagerstam & Blom, 2013; Wells, 2000), increase learning (Maynard, Waters, & Clement, 2013), reduce stress (Chawla, Keena, Pevec, & Stanley, 2014; Woodgate & Skarlato, 2015), diminish the effects of Attention Deficit Disorder (Taylor, Kuo, & Sullivan, 2001; Taylor & Kuo, 2009), manage depression (Zaradic & Pergams, 2007), increase empathy for living things (Schein, 2014; Cheng & Monroe, 2010), reduce incidences of bullying (Louv, 2013), improve social and collaborative skills (Cheng & Monroe, 2010), and foster creativity (Kahn & Kellert, 2002; Atchley, Strayer & Atchley, 2012).

Therefore, serious consideration should be given to the need for greater environmental literacy and improved environmental education. Such a focus is not incompatible with an increased use of technology, but rather offers a more balanced approach to promoting student learning, creativity, collaboration, and health. Moreover, the global community widely acknowledges that we are facing unprecedented challenges to maintaining a healthy planet. The Pew Research Center reported that the human population in 2010 was 6.9 billion, a number that was expected to increase nearly 40% to 9.6 billion in 2050. As human beings encroach on even more previously undeveloped areas, destroy fragile ecosystems, increase the use of chemical pesticides and fossil fuels, and divert more rivers and streams, the rate of extinction for other species has accelerated precipitously (Kolbert, 2014). Louv (2011) noted that, for the first time in history, more than half the world's population now lives in cities or towns and warned, "The traditional ways that humans have experienced nature are vanishing, along with biodiversity" (p. 3). Schools in the United Kingdom and other European and Scandinavian countries have already adopted policies that will require schools to become sustainable by 2020, not only from a practical standpoint, but also a curricular one (Huckle, 2009). The goal is to empower students with the skills and knowledge necessary for life in an interconnected and sustainable world.

Success Stories

Some schools in the United States, such as Eagle Cove School in Pasadena, Maryland, long ago adopted a focus on sustainability and environmentalism, earning multiple state, national, and international "green school" awards for such programs as reusing paper and other materials; recycling, upcycling, composting, and rain barrels; raising monarch butterflies, tadpoles, endangered terrapins, and horseshoe crabs; holding a fully cross-curricular Earth Week celebration; and having such school attributes as a rain garden, green roof, nature trail, oyster bed, and greenhouse. Studies have shown that schools with a comprehensive sustainability focus extend their influence from the classroom into the home lives of students and parents, wherein families reported greater awareness of environmental issues and their place within local and global ecosystems, as well as an increase in "green" behaviors, such as recycling, composting, reducing electrical usage, making purchases based on the ability to reduce or recycle packaging, and modifying driving habits to conserve fuel (Hill and Decker, 2014; Legault & Pelletier, 2000).

Four other schools in a study by Higgs & McMillan (2006) found similar results, as well as evidence to support the assertion that "modeling allows schools to foster learning about sustainability and the adoption of sustainable behaviors without the need to preach" (p. 50). Not only did all of the schools succeed in building a cohesive culture with strong links to students' homes and the broader community, but all saw a reduction the cost of paper and other supplies, food waste, and energy costs—all important considerations in an era of constrained school budgets. Unfortunately, the schools featured in these studies are still the exception in the United States. In fact, some schools are moving in the opposite direction when it comes to helping students respect and connect to the natural world, as they eliminate or reduce recess or do not hold recess outside, thus isolating children even more from the benefits of outdoor contact and play (London, Westrich, Stokes-Guinan, & McLaughlin, 2015).

Need for Broader Integration

As people spend more time indoors, their interactions and experiences with nature become increasingly less meaningful. Louv (2005) described a phenomenon called "Nature Deficit Disorder" in which children who are more connected to electronic devices than to the natural world not only lose opportunities to gain important knowledge but also place lesser value on open spaces, wild places, and threatened habitats that they will one day be charged with protecting. They are also less likely to engage in sustainable and "green" behaviors. Coyle (2005) asserted that most Americans lack knowledge and awareness of the natural sciences, ecology, and pressing environmental issues facing the world in the 21st century. Moreover, Zeyer and Kelsey (2013) made a distinction between "environmental education" and "environmental information," noting that students in their study were able to identify and describe environmental concepts but were unable to conceive of the issues within a broader cultural or societal perspective. Moreover, the students were less inclined to consider social or behavioral solutions, but rather placed their hope "with science and technology and credited technological progress with the largest potential to improve environmental protection" (p. 209). This phenomenon serves to highlight an important distinction between traditional approaches to science education and environmental science.

Cairns (2011) suggested that there is a widespread belief in the idea that science is "totally separate from social issues and therefore remains 'pure' and 'non-judgmental'" (p. 53). Cairns further posited that environmental education affords a much needed opportunity to incorporate ethics and values by presuming a "value judgment that eco-systems are important and worth protecting, conserving, restoring, and treasuring" (p. 53). In addition, environmental issues can easily be linked to such pervasive social issues as war, poverty, immigration, consumerism, mental and physical health, and globalization, as well as such key components of education as citizenship, critical thinking, collaboration, and diversity. Thus, environmental education broadens the scope and impact of overall science education. If the children of today are going to be the environmental stewards of the future, then that future will be bleak unless teachers and administrators are willing and equipped to be agents of change and improve overall environmental literacy in U.S. schools.

A number of advantages to environmental education blend well with recent educational trends: critical thinking, student empowerment, students as researchers, place-based education, and diversity. Due to the sometimes controversial nature of environmental issues, environmental education requires that students think critically about the accuracy and sources of information they analyze. For example, a recent article from the *Sacramento Bee* newspaper described the deleterious effects of California's ongoing drought, particularly in regard to farmers' pumping groundwater to the point where the Central Valley has been sinking rapidly.

In this article that had been bolstered by data from NASA and other government agencies, the last word was given to the president of the California Farm Bureau Federation, who claimed that the dwindling aquifers and sinking ground levels could be resolved by allowing farmers to have more of the available supply of surface water. The CFBF president claimed that "most of the water that farmers use for irrigation seeps back into the ground anyway, helping to recharge the aquifers . . . once we put water in the ground, it's not going to evaporate . . . it's kind of there" (Kasler, 2015, n.p.). These statements were not challenged by the reporter, despite the fact that they were inaccurate and misleading, and were presented as fact under the myth of scientific legitimacy. Students who are taught critical thinking and also are armed with an enhanced understanding of both scientific principles related to the water cycle and key environmental issues, especially local ones, would be in a better position to more accurately evaluate the article and the information provided.

Another advantage involves empowering students to be agents of change and encouraging students to participate in research. Lundholm, Hopwood, and Rickinson (2013) conducted a meta-analysis of research about student experiences in environmental education and found a common theme of the “conceptualization of learners as active agents, rather than passive objects, in the learning situation” (p. 244), because the curriculum engaged the students’ emotions and values, was relevant to their personal and professional futures, and required them to consider multiple points of view. Hacking, Cutter-Mackenzie, & Barratt (2013) pointed to additional opportunities for student engagement through activities and projects that involve students as researchers, either through projects and studies created for and within their own schools and communities or as part of broader projects sponsored by organizations and institutions like the Cornell Lab of Ornithology’s BirdSleuth program, Terracyle’s collection programs, and the University of Kansas and the University of Minnesota’s Monarch Watch.

Through an emphasis on place-based education, learning can be much more highly contextualized. Deep exploration of places can combat the previously mentioned disconnect with the natural world. Smith (2013) claimed:

> When electronic media and schools together direct children’s attention away from their own lived experience, it is not surprising that they find it difficult to become attached to and responsibly involved with their communities. Nor is it surprising that they are spending less and less time getting to know natural places within or beyond their neighborhoods. (p. 213)

Furthermore, Smith (2013) asserted that engaging students more directly in their social and natural communities will help them to better understand their place within the broader global community, preparing them to both compete for jobs and cooperate with others for the common good. Fostering a sense of place also invites opportunities for increased cultural diversity and awareness by including indigenous knowledge. Research by Lowan-Trudeau (2013) suggested that multicultural education aims can be furthered by comparing indigenous and Western ways of thinking about knowledge, “creating opportunities to connect with the land, employing indigenous instructors as role models, involving elders as experts,” and exploring the interconnection between native languages, cultures, and their surrounding ecological systems (p. 405).

Preservice Teacher Education

Given the potential for environmental education to enhance overall educational goals, teacher educators would be wise to consider ways to increase environmental literacy within preservice teacher education. Environmental literacy, as defined by Disinger and Roth (1992), is “the capacity to perceive and interpret the relative health of environmental systems and take appropriate action to maintain, restore, or improve the health of those systems” (n.p.). Subsequent efforts to expand and refine the definition and components of environmental literacy led to the inclusion of “environmental sensitivity, ecological knowledge, environmental emotion (attitudes), issue and action skills, verbal commitment (willingness to act), and actual commitment (behavior)" (McBeth & Volk, 2010, p. 57).

Within the context of teacher education, environmental literacy falls under the programmatic umbrella of environmental education (EE). In 2000, McKeown-Ice conducted a national study of institutions of higher learning offering teacher-preparation programs in order to explore why EE was not being more effectively integrated into the curricula. The study identified several important barriers, including the following:

1. Lack of mandates from accrediting bodies, such as the state departments of education and the National Council for Accreditation of Teacher Education (NCATE), to include EE in the teacher preparation curriculum.
2. Lack of correlation between EE and state and national standards.
3. Lack of faculty with content expertise, interest, or commitment to EE. (McKeown-Ice, 2000)

In 2010, the Obama administration became the first to include environmental literacy in the U.S. Department of Education budget, noting the correlation between "increasingly complex environmental and related economic, social, natural resource, and energy issues," as well as the connection to Common Core and Next Generation Science Standards (No Child Left Inside Coalition, 2010, n.p.). This was certainly an indication that those barriers might not be as daunting as before, and there are indeed improvements to be found in 2015.

First, the North American Association for Environmental Education (NAAEE, 2014), a national membership organization dedicated to strengthening the field of environmental education and increasing the visibility and effectiveness of the profession, entered into a partnership with NCATE to provide accreditation standards for the preparation and professional development of environmental educators. Though NCATE does not require EE as part of its overall accreditation criteria for teacher education programs, the organization did approve the NAAEE standards for environmental education that are now used to certify EE programs. Thanks, in part, to the perceived legitimacy of that NCATE/NAAEE collaboration, 13 states have adopted and implemented an Environmental Literacy Plan (ELP) for the purposes of integrating "environmental education into the K–12 curriculum [that] will give teachers and students new opportunities to take learning outside; explore their communities; analyze issues; learn about connections between our economy, society, and environment; support economic growth; and become engaged citizens" (NAAEE, 2014, p. 2). Another 34 states are in the process of drafting or adopting ELPs.

Second, EE standards are now aligned with Common Core and Next Generation Science Standards (Simmons, 2015). Third, more universities are offering degrees in environmental sciences. According to the Bureau of Labor Statistics, U.S. Department of Labor (2015), "employment of environmental scientists and specialists is projected to grow 15 percent from 2012 to 2022, faster than the average for all occupations" (n.p.). Therefore, there are likely to be more teacher-preparation faculty members with the appropriate qualifications for teaching EE within that context.

Despite these gains, to date only four institutions of higher learning have earned EE accreditation through NAAEE/NCATE. Moreover, many of the state proposals for adopting Environmental Literacy Plans have faltered because they are unable to find funding "to support creation, adoption, implementation, and/or assessment of their ELPs" (NAAEE, 2014). Without mandates from the states, many of which are looking to decrease the number of credits required for graduation (Mastrilli, 2005), most institutions of higher learning will not voluntarily integrate additional courses focused on EE into teacher-education programs that are already overburdened by numerous and often onerous accreditation requirements (Heimlich, Braus, Olivolo, McKeown-Ice, & Barringer-Smith, 2004).

A study of North Carolina's Environmental Education Certification Program revealed important implications, noting that 71% of the educators certified through that program had been teaching 11 years or more. This means that "unless teachers receive preservice EE in their teacher education programs, teachers may spend at least 10 years of their teaching careers without the benefit of formal methods and materials on teaching EE" (Bennett & Matthews, 2005). If preservice teacher-education programs cannot or will not integrate EE, despite the proven benefits, then the burden of responsibility once again falls to individual teachers, schools, and districts to seek and/or provide opportunities for professional development through professional organizations or community-based partnerships that offer programs for both teachers and students.

In addition to national organizations such as NAAEE, many statewide organizations—such as the Maryland Association of Environmental and Outdoor Education (MAEO), the California Association for Environmental and Outdoor Education (AEOE), and the Wisconsin Association of Environmental Educators (WAEE)—publish newsletters, host web-based resources, and organize small state or regional conferences for teachers one to three times a year to share experiences and expertise and to promote best practices. Some schools are also fortunate enough to be geographically convenient to locations and resources that allow for partnerships both on and off the school campus. For example, the small, non-profit Agua Hedionda Lagoon Foundation in Carlsbad, California, provides third-grade students from schools in the greater North San Diego County area with a series of hands-on, full-day workshops on the grounds of the nature center, covering such important topics as life in and around the local watershed, invasive species, pollution, and clean energy.

Larger, well-funded organizations, like the Cornell Lab of Ornithology in Ithaca, New York, host school groups at their nature centers not only to learn about issues such as biodiversity and conservation, but also to provide resources for educators nationwide to conduct field surveys in their own communities. One of the most widely used programs for conservation and environmental education is the Texas-based Project Wild, which provides workshops and resources for teachers and students on a variety of topics that foster "responsible action towards wildlife and natural resources" (About Us, n.d.). Nevertheless, as dedicated as these organizations may be, they are all focused primarily on inservice, rather than preservice teachers; and the approaches they offer are best characterized as workshops or enrichment, rather than comprehensive and scaffolded for maximum impact.

Teachers and administrators whose only exposure to environmental literacy and education is conducted in such a piecemeal fashion are unlikely to become the leaders that schools need in order to adopt and maintain a culture of sustainability and to promote balance for their students between a virtual world that is growing exponentially and a natural world that is rapidly disappearing. Louv (2011) postulated a new "hybrid mind" that will be achieved only by utilizing both technology and a tangible connection to nature to "increase our intelligence, creative thinking, and productivity" (p. 5). A transformation of this magnitude requires more than a change in worldview; rather, it requires being part of the process of changing the world (Singleton, 2011). It is unlikely that such a transformation would result solely from grassroots efforts. It requires the legitimacy bestowed by higher education and its accrediting bodies at state and national levels. Given the growing body of research on the topic, it is no exaggeration to assert that the health of our children and the future of our planet depend, at least in part, on improving environmental literacy in the United States.

Finding a Solution

A possible approach that might be more palatable to some teacher-preparation institutions involves mandating environmental education within early childhood education (ECE) programs. By locating preservice environmental education under the umbrella of ECE, there is a natural fit with state preschool frameworks that recommend time for unstructured exploration and discovery learning. The level of content expertise in the sciences for ECE teachers is not as rigorous and, therefore, many aspects of environmental education courses would be appealing to a broader audience. Moreover, smaller class sizes and general availability of outdoor play spaces lend themselves to more opportunities for authentic clinical practice in the field.

In a recent presentation at the North American Association for Environmental Education conference, Bhagwanji (2015) from Florida Atlantic University emphasized the importance of requiring ECE teacher candidates to learn and teach outside in order to increase their own comfort levels and to help them minimize any aversions they might have to naturally occurring outdoor phenomena (dirt, insects, etc.) so that they will not, in turn, pass along their discomfort or phobias to the next generation. Bhagwanji further emphasized the importance of exposing ECE teacher candidates to the "wild places" in their area, so that they would be familiar with the natural resources available in their own communities.

For both teacher candidates and the children they teach, authentic experiences are key. Videos and other virtual experiences cannot replace the connections that occur from learning outdoors, though technology can certainly be easily integrated into outdoor experiences in order to enhance teachable moments. ECE classes aimed at furthering environmental literacy might also include activities related to children's health and development issues discussed earlier, as well as protecting and restoring natural habitats; caring and respecting animals, plants, and other living things; making sustainable choices; and engaging in active content learning.

By increasing the number of teacher candidates involved in environmental education, as well as the number of clinical situations characterized by outdoor or place-based environments, researchers would be able to add to a body of knowledge that has suffered from a lack of research opportunities. If more extensive research in the area of early childhood education is able to bolster the claims of initial and limited studies now available, perhaps it would provide the impetus needed to mandate environmental literacy for preservice programs aimed at elementary and secondary students.

Holdsworth, Thomas, and Hegarty (2013) made a distinction between education *about* sustainability, education *for* sustainability, and educating *as* sustainability. The first does not challenge the current educational paradigm. The latter two levels require a more critical and transformative approach that the authors claimed is the unique purview of universities. Likewise, Jucker (2002) asserted:

> Universities produce those that will reproduce the existing power structures. Academics themselves create and run society's political and social institutions that in theory underpin and run our capitalist economy and technological direction,…and educate our students, (p. 242)

Therefore, it is incumbent upon teacher educators to look beyond the programmatic barriers that still exist and to advocate for the formal integration of EE within preservice teacher education, perhaps starting with ECE, in order to facilitate this important cultural correction before the pendulum swings too far in the direction of valuing simulated experiences over real ones, both in the classroom and in society at large.

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The Flipped Classroom in a Hybrid Teacher Education Course: Teachers' Self-Efficacy and Instructors' Practices

Patricia Dickenson

Abstract
The hybrid course format provides the means for self-directed asynchronous activities like the flipped classroom to take place in a virtual space, which can free up valuable face-to-face class time. The amount of empirical research on applying the flipped classroom to a hybrid university course is limited. To study this problem, a case study involved a comparison of two hybrid teacher education classes: one using traditional lecture during face-to-face meetings, and the other providing video lecture. Measures of candidates' confidence towards teaching were compared through self-assessment. Results found statistically significant differences in confidence gains when participants experienced the flipped classroom.

Keywords
Flipped classroom, self-efficacy, teacher preparation, pre-service teachers

Introduction: Flipped Classroom

In higher education, the "flipped classroom" is an approach to instruction where students typically watch prerecorded lectures at home so "in class" time may be used to collaborate with classmates, work in small groups, or engage in project-based activities (learner-centered activities). Existing literature has shown the flipped-classroom method has a greater learning effectiveness than traditional methods (Bergmann & Sams, 2012; Gannod, Burge, & Helmick, 2008; Gerstein, 2012; Kachka, 2012; Lage, Platt, & Treglia, 2000; Shimamoto, 2012; Strayer, 2007; Warter-Perez & Dong, 2012; Zappe, Leicht, Messner, Litzinger, & Lee, 2009). The ability to digitize the instructor's lectures for viewing and reviewing at the student's pace is a key motivator for using video recorded lectures. In addition, the flipped classroom approach frees up class time for increased interaction with teachers and peers. Research has suggested this approach would drive students to self-monitor, enhancing metacognition, and thereby increasing self-regulation and improving learning effectiveness (Labuhn, Zimmerman, & Hasselhorn, 2010).

Teacher-centered approaches include instruction where the teacher presents information that is to be learned, and directs the learning process of students (Shuell, 1996). Direct instruction is a teacher-centered approach that includes four components: (a) introduction and review, (b) presentation of new information, (c) guided practice, and (d) independent practice. In a traditional class greater emphasis is placed on lecture, which is controlled by the teacher. The lecture format allows the instructor to communicate information to a diverse group of students in a short time. Research suggests lecture-based classrooms do not provide opportunities for students to extend their thinking beyond the class term (Udovic, Morris, Dickman, Postlethwait, & Wetherwax, 2002). Many instructors want to change their instructional style from traditional lecture to a more active student-centered approach (Baker, 2000). As lectures are usually passive in nature, little dialogue tends to take place between the lecturer and student.

The flipped classroom is an approach to lecturing where the passivity of listening to a lecturer takes place in the comfort of home. This provides the student with an opportunity to process the information and think about questions that might support their understanding. Further, students may review the lecture several times and respond to questions proposed in the lecture as homework. This type of format provides the instructor with a better understanding of what material is being learned and what might need to be retaught. In addition, with the flipped approach the instructor has a greater opportunity for learner-centered activities to take place during class time. Learner-centered activities provide students with some control in the learning process and require active participation such as through peer collaboration, group discussions, and project-based learning.

Teacher education programs focus on preparing candidates to be effective classroom teachers who positively impact K–12 student learning. Teacher candidates must be afforded an opportunity to observe, develop, and demonstrate pedagogical practices within the context of their program. Teacher education programs are challenged with providing a space for all candidates to interact with their instructor and peers in a way that informs their practice and the instructor's ability to give formative feedback. The instructor's pedagogical choices can determine how time is spent online and in the traditional classroom space. Research suggests professors' instructional strategies influence pre-service teachers' self-efficacy (Nietfeld & Cao, 2003). Pre-service teachers with high self-efficacy will tend to experiment with methods of instruction, seek improved teaching methods, and experiment with instructional materials (Allinder, 1994).

Examining pre-service teachers' self-efficacy and how it is shaped by an instructor's pedagogy is an important aspect for consideration. This exploratory study investigated whether a flipped approach to teaching a particular course makes a difference in measures of self-efficacy of two groups of students: one whose instructor used a non-traditional, flipped approach to teaching (the experimental group), and the other (the control group), whose instructor used a traditional method of teaching.

Review of the Literature

Flipped Classroom in Higher Education

In higher education, the flipped-classroom model was referred to as the "inverted classroom" and included lectures that were made available on VHS tapes (Alexander, 1995). The inverted classroom is a similar pedagogical approach to the flipped class, as students watched prerecorded lectures at home or in a computer lab. Face-to-face instruction was used to answer student questions and engage in hands-on activities. The flipped approach emerged as an educational tool in 2006 by Jonathan Bergmann and Aaron Sams (2012) and is characterized by the use of Screencasting to deliver instruction that can be accessed at any time and place. This instructional approach has been embraced by teachers from primary school to higher education as a means of maximizing time to collaborate, problem solve, and investigate content areas. The terms *flipped classroom* and *inverted classroom* will be used interchangeably throughout the review of the literature.

Lage et al. (2000) found the inverted classroom approach to be favored among undergraduates in an economics class. Students' perceptions of the inverted classroom were examined by conducting end-of-course surveys with students enrolled in the inverted classroom. Students responded favorably to the inverted approach and preferred this type of instruction to the traditional method. In a study conducted at the University of Irvine (Moravec, Williams, Aguilar-Roca, & O'Dowd, 2010), students enrolled in a traditional large lecture biology class were switched to an inverted classroom that included prerecorded videos and interactive exercises. Students' achievement in the inverted classroom increased by 21% on exam questions that were covered in lecture and included in prerecorded videos. Most recently, Moravec et al. (2010) found an increase in student achievement when a flipped approach to instruction was used among undergraduates in an introductory course for biology. Students showed a small but significant improvement by the midterm, and this improvement increased by an additional 8.6% on the final exam. Further, Gannod et al. (2008) found stronger self-ratings of students' ability to write application software and high levels of student engagement when students experienced the inverted classroom approach. Talbert (2012) used the inverted classroom approach as a choice of solution techniques on a final exam problem. Students who watched the solution technique from the prerecorded video had a significantly higher success rate than students who participated in the in-class lecture. Relatively little research has been conducted on the flipped classroom, and this approach has yet to be explored in a teacher education course.

Self-Efficacy

"Self-efficacy is the belief in one's capabilities to organize and execute the courses of action required to manage prospective situations" (Bandura, 1995, p. 2). A significant amount of research on self-efficacy demonstrates numerous factors that influence people's belief in their confidence to complete a task. Previous experience strongly influences self-efficacy. Self-efficacy will increase when students experience success in the classroom; and when students experience failure, self-efficacy will decrease. When observing others perform a similar task, referred to as modeling, self-efficacy may be influenced as well (Ormrod, 2006). A live model is especially salient when people have limited prior experience or they are uncertain about their own ability. In the teacher education classroom, pre-service teachers need an opportunity to observe the modeling of strategies. Often, teachers learn about research-based best practices through course readings and lecture but do not have an opportunity to either experience or observe these practices until they are working as a classroom teacher.

Teacher efficacy can be described as the teacher's belief in the ability to organize and execute courses of action required to successfully accomplish a specific teaching task in a particular context (Tschannen-Moran, Hoy, & Hoy, 1998). Beginning teachers need strong self-efficacy beliefs in order to continue in the field of education (Mulholland & Wallace, 2001). Teachers who exhibit high levels of self-efficacy are also more satisfied with their job and more empowered as teachers (Edwards, Green, & Lyons, 2002). Furthermore, a teacher's experience during student teaching practice has also been correlated with higher self-efficacy levels (Bandura, 1997; Mulholland & Wallace, 2001; Pajares, 1997).

Gerges (2001) investigated the factors that influence pre-service teachers' variation in their use of instructional methods. Pre-service teachers with little to no experience with a specific teaching method had a lower rating of teacher efficacy and were less likely to implement new teaching methods in their classrooms. Therefore an opportunity to observe relevant models as well as demonstrate instructional methods is paramount to influencing pre-service teachers who have lower teacher efficacy.

Nietfeld and Cao (2003) examined the type of instructional strategies that promote pre-service teachers self-efficacy within a college course. Students perceived active, more than passive, instructional strategies to be important for increasing their personal teaching efficacy. Empirical research also shows that active learning leads to increased gains in knowledge when compared to traditional lecture, as students are continuously engaged and participating when instructors use active instructional strategies (Smith & Cardacitto, 2011). Active learning strategies include any type of activity, either individual, peer or group work that requires students to actively engage in a task rather than passively listen to a lecture.

Study Context

About the Participants

Participants in this exploratory study included 48 teacher education candidates and two adjunct instructors at a large university in California. Participants had completed methods and core courses prior to being enrolled in the student teaching seminar course in which this study took place. Participants were pursuing a California teaching credential and were currently engaged in 80 days of student teaching at a designated public school site. Students were randomly assigned to one of two identical courses at the university. The course content and assignments were identical in each course and created by a university professor who was not teaching either class. Both the experimental and control groups had access to the course material through an online learning management system. Instructors in both the control and experimental group held monthly face-to-face classes with participants throughout the five-month course period. The instructors were purposefully selected to participate in this study: One instructor identified as teaching in a traditional way, whereas the other instructor espoused learner-centered approaches, including the flipped-classroom approach, for delivery of lecture.

Data Analysis

Data were collected from three primary sources: interview with instructors via email, pre- and post-assessment of participants' confidence in teaching, and exit interviews. The participants completed a pre- and post-survey about their confidence toward teaching and a post-survey only about their perception of the instructional approaches used throughout the course. Students' confidence toward teaching was measured with the TSES 24-item long form (Tschannen-Moran & Hoy, 2001). These items are grouped into three subscales: efficacy for student engagement (SE; 8 items), efficacy for instructional strategies (IS; 8 items), and efficacy for classroom management (CM; 8 items); Cronbach's coefficient: SE (0.89 and 0.92), CM (0.91 and 0.94), IS (0.91 and 0.94), and total scale (0.96 and 0.97). Teacher efficacy was measured at the beginning and end of the course using a five-point Likert-type scale ranging from "Not at all confident" to "Extremely Confident." Pre- and post-test self-report of students' perceived "teacher efficacy" was compared between and within groups to determine if differences were statistically significant.

Participants also completed an online survey at the end of the course to determine which instructional strategies promoted a sense of classroom community. "What strategies did the professor implement to help you feel a sense of community?" and "What strategies do you feel the professor should implement to relieve a sense of isolation in a hybrid course?" are two examples of questions that were included.

Results

Pedagogy Differences

Email interviews with course instructors revealed differences in the class structure and format. The instructors were asked to email their classroom agenda for each course meeting. The control group received traditional course lectures during face-to-face meetings, whereas the experimental group received a flipped-classroom approach to onsite meetings. In the flipped model, participants watched prerecorded lectures at home, and face-to-face instruction was used for students to work collaboratively on project-based activities, student-led presentations, case studies, and collaborative lesson planning related to course material. Each course met for approximately 4 hours, which included a 30-minute lunch break. Table 1 illustrates the traditional (control group) and flipped (experimental group) classroom schedule.

Table 1. *Class Schedule for Student Teaching Seminar*

Flipped teacher education classroom (based on 230-minute block schedule)		Flipped teacher education classroom (based on 230-minute block schedule)	
Teaching activity	**Duration**	**Teaching activity**	**Duration**
Agenda and objectives	10 minutes	Agenda and objectives	10 minutes
Review prior material	20 minutes	Review podcast material/questions	20 minutes
Lecture	60 minutes	Group work	60 minutes
Group work	20 minutes	Presentations	20 minutes
Break	30 minutes	Break	30 minutes
Lecture	60 minutes	Group work	60 minutes
Group work	20 minutes	Presentations	20 minutes
Closing	10 minutes	Closing	10 minutes

Teacher-led activities are considered any activity in which the instructor is directing the discussion. In the traditional class, about 67% of class time was devoted to teacher-led activities, which included agenda and objectives, review prior material, lecture, and closing. In the flipped classroom, about 17% of class time was spent on teacher-led activities. This finding suggested the flipped-classroom model was effective at significantly reducing the amount of time lecturing and engagement in teacher-led activities. When asked “How do you structure classroom lecture in the classroom?” the instructor in the control group used a PowerPoint presentation that reviewed key ideas and concepts. The control group teacher shared he would randomly call on participants to share their responses and provide feedback. When asked “How do you check for student understanding?” The control group teacher shared that lecture was followed by group work in which students explored a concept or question related to the lecture with their colleagues. The instructor in the experimental group stated that lecture included a prerecorded video that students watched independently prior to the class. The experimental instructor used a variety of strategies to check students understanding of the prerecorded video, including discussion board posts, quick writes that the student would complete upon entering the class and online classes. In the flipped classroom, the instructor provided participants with handouts and an agenda. Handouts included case studies for group discussion, rubrics for student-led presentations, and templates for designing instruction and activities for project based learning. Peer evaluation was a key component of in-class presentations, where participants provided groups with feedback as they presented to the larger group. Presentations were not part of the control group, as students did not purposely prepare an activity or design a task that was shared with classmates during the in class session.

Teacher Confidence

Participants' self-report of their perceived confidence toward teaching was measured at the beginning and end of the study through pre- and post-survey in both control and experimental groups. The following four statistical comparisons among the groups were made: pre-control versus pre-experimental, post-control versus post-experimental, pre-post control, and pre-post experimental. The gain scores of experimental and control groups were also compared to determine if there were significant differences in the pre- and post-survey between groups.

Table 2 suggests a higher mean in the control group confidence toward teaching at the beginning of the study. The difference between means of the control and experimental groups was .42, which was found to be significant on a five-point scale. The resulting *t*-statistic revealed that the difference in teaching confidence between groups was significant ($p < .05$). The second comparison on teacher confidence in this study was the post-control vs. post-experimental. Table 3 reports the results of this study.

Table 2. *Pre-Control and Pre-Experimental Groups' Confidence toward Teaching*

Variable	Group	*M**	*n*	*SD*	*t*	*df*	*p*
Confidence teaching	Control	3.39	24	0.41	3.56	46	.0009
	Experimental	2.97	24	0.407			

*Higher mean, positive confidence toward teaching.

Table 3. *Post-Control and Post-Experimental Groups' Confidence toward Teaching*

Variable	Group	*M**	*n*	*SD*	*t*	*df*	*p*
Confidence teaching	Control	3.92	24	0.30	0.096	46	0.9236
	Experimental	3.91	24	0.41			

*Higher mean, positive attitudes toward mathematics.

The comparison on teaching confidence between control and experimental groups at the end of the study indicated no significant difference ($p > .05$).

In order to compare means between pre- and post-administration of the confidence toward teaching in control and experimental groups, the statistical analysis carried out was an unpaired samples *t*-test. Tables 4 and 5 summarize the results of the comparison between pre- and post-administration of the confidence scale toward teaching in the control and experimental groups, respectively.

Table 4. *Pre- and Post-Confidence in Teaching: Control Group*

Variable	Group	*M**	*n*	*SD*	*t*	*df*	*p*
Confidence teaching	Pre-control	3.40	24	0.409	5.19	46	0.102
	Post-control	3.93	24	0.308			

*Higher mean, positive confidence toward teaching.

The difference between means of the pre- and post-survey was about 0.53, which was found to be significant. The resulting *t*-statistic revealed that the difference in teaching confidence within the control group was significant ($p < .05$). Table 5 reports the comparison between pre- and post-administration on confidence toward teaching in the experimental group.

Table 5. *Pre- and Post-Confidence toward Teaching: Experimental Group*

Variable	Group	*M**	*n*	*SD*	*t*	*df*	*p*
Confidence teaching	Pre-experimental	2.970	24	0.407	7.97	46	.0001
	Post-experimental	3.916	24	0.414			

*Higher mean, positive attitudes toward mathematics.

The mean differences between the pre- and post-survey for the experimental group was about 0.95, which was about 40% greater than the mean differences in the traditional group. Similarly, for these comparisons, significant difference ($p > .05$) was found within the groups in confidence toward teaching.

Considering significant differences were found between the control and experimental group during the pre-test measurement, (which may be due to failure in the randomization), an additional group comparison was conducted. According to Overall,1989), one way to resolve the differences between groups prior to the treatment is to compare group differences between post-test and pre-test, referred to as change or gain scores. Table 6 reports the comparison between pre- and post-test gain scores in the control and experimental groups.

Table 6. *Gain Score of Pre- and Post-Confidence in Teaching: Control vs. Experimental*

Variable	Group	*M**	*n*	*SD*	*t*	*df*	*p*
Gain score	Control	0.55	24	0.34	3.9	46	.0003
	Experimental	0.947	24	0.36			

*Higher mean, greater gain in confidence in teaching.

The resulting *t*-statistic reveals that the difference in gain score between pre- and post-test of teaching confidence between the control and experimental group was significant ($p < .05$). The experimental group was found to have a significantly higher gain in teaching confidence than students in the control group.

Perception of Instructors' Pedagogy

In addition to the pre- and post-survey of teaching confidence, students also responded to open-ended survey questions about their experience in the course. When asked, "What strategies did the professor implement to help you feel a sense of community?" students in the control group were more likely to report personal attributes of the classroom instructor rather than actual instructional strategies. Participants' responses included "the instructor was very professional" and "he was open and shared his experiences." Among control group responses there was a common theme of personal attributes of the instructor. This finding reinforces the notion that teacher-centered instructional approaches focus on knowledge construction by the teacher and passive learning by the students.

In the experimental group, however, students reported the instructors' strategies to be indicative of a learner-centered teaching approach. When asked "What strategies did the professor implement to help you feel a sense of community?" the students stated, "making connections with colleagues," "group presentations," "sharing experiences," "class projects," and "feedback from instructor and colleagues." These strategies are aligned with a learner-centered approach to teaching where the teacher facilitates understanding by creating a classroom environment that is conducive to conceptual change. In a learner-centered classroom, participants can engage in activities that focus on a deep approach to learning and understanding the content of study.

When asked "What strategies helped promote course discussion?" the majority of participants in the experimental group reported "instructor videos" were useful to help promote discussion. The experimental instructor used a web-based screencasting program to record video lectures. When asked about the strategies the instructor used to support a flipped-classroom approach, the experimental instructor found this to be a useful tool because of the capacity to have unlimited recording time, and provide students with the accessibility to watch course lectures either on their mobile phone or home computer. Four videos were created for each unit of study. Video statistics revealed that, on average, each video was viewed at least 30 times by the end of the course. These data reveal students in the experimental group may have watched the video more than once, as students in the control group did not have access to teacher-created videos.

The survey also asked participants "What strategies should the professor implement?" participants in the control group were more likely to skip this question or report "not applicable." In the experimental group, however, participants were more likely to give formative feedback related to the instructors' strategies, such as "more time for group work," "more instructor videos," "team building skills," and "rotate groups more often." The responses in the experimental group were identical to the strategies incorporated into the course. This implies students found these strategies meaningful and relevant. The experimental groups' responses also demonstrated a mastery classroom environment, where the goal of learning is to master new skills and the process of learning itself is valued. This is indicative of the fact participants in the experimental group were more likely to provide constructive feedback versus participants in the control group, who were more likely not to provide a response. When the classroom environment is focused on getting good grades and looking competent as compared to others, this leads students to adopt a performance-goal orientation. Students would be less likely to provide constructive criticism if they believed this would impact their grade.

Discussion

In this study, the gains in teacher confidence were significantly greater in the flipped-classroom model. The flipped-classroom model is aligned with a learner-centered approach to instruction, as the focus is more on the students and their learning than on the teachers and their teaching. A learner-centered approach allows students to construct knowledge, as well as aim toward mastery of content. The instructor in a learner-centered classroom has a greater opportunity to scaffold instruction based on individual needs, as teaching is interactive and the instructor can observe students' misconceptions. Although both the traditional and flipped classroom incorporated group work into the class schedule, the amount of time allotted for group work was significantly greater in the flipped class than in the traditional class; in the traditional class, about 17% of class time was allocated for group work, compared to 67% of class time in the flipped classroom. Furthermore, in the flipped classroom an additional 40 minutes of class time, or about 16%, was used for group presentations. This additional time allowed the instructor to create activities that required a higher level of cognitive demand and for students to demonstrate their knowledge during group presentations. This additional time permitted the experimental teacher to engage in additional teaching strategies, versus the traditional approach. Coffee & Gibbs (2002) found student-centered teachers have been found to use a wider repertoire of teaching methods than teachers who adopt a teacher-centered approach to teaching.

In a traditional course, presentations are from the instructor and not necessarily the student. This approach may not provide pre-service teachers with an opportunity to lead a discussion and demonstrate mastery of the content. If pre-service teachers are preparing to enter the classroom, they will need multiple opportunities to present ideas and collaborate with colleagues, which is typically what pre-service teachers will do as classroom teachers. The flipped-classroom model lends itself to a greater amount of time for group work, thus providing an opportunity for students to collaborate, share ideas, negotiate meaning, and receive instructor feedback.

The results from this study support previous findings that instructional approaches do influence teacher efficacy (Nietfeld & Cao, 2003). This is an important finding for higher-education instructors to take into consideration, especially as more schools and universities move to alternative classroom environments such as hybrid, synchronous, and asynchronous classes. Knowing what type of instructional approach is most effective can help instructors support such positive student outcomes as mastery of course content, retention, and graduation.

Limitations and Recommendations for Future Research

The findings of this study may be generalized to other teacher education coursework, as prerecorded lectures can be an effective way for instructors to provide students with direct instruction without using valuable instructional time in a face-to-face classroom. Future research should examine how prerecorded lectures are perceived and valued by pre-service teacher candidates and if access to these lectures impacts their efficacy as well as understanding of course content. A within-group research design in which the same participants receive both the traditional lecture and flipped approach would be an effective way to measure the influence of the flipped-classroom approach. As several variables influenced students' perception in this exploratory study, it is difficult to control for which variable had the most significant impact on students' efficacy. The increase in group work time and student-led presentations, which were only in the experimental group, could also contribute to differences in the experimental group's efficacy.

What was surprising in this research study was the type of feedback from participants in different groups. Small-group and individual interviews with participants would be useful to determine why the variance in quality of participants' feedback existed, as participants in the experimental group were more likely to provide descriptive feedback when asked about the instructors' strategies, whereas participants in the control group were more likely to provide evaluative feedback. Future studies should examine how student feedback with the flipped model might be useful to shape how instructors create and share prerecorded lectures.

Differences were also found in how students perceived the instructor's teaching practices and how their perception was related to their sense of classroom community. Future studies should include classroom observations, to determine how instructional practices are being implemented. Group interviews could provide greater insight into which practices participants found to be effective or ineffective.

Conclusions

Instructors' pedagogical approaches influence how students perceive the classroom environment and shape participants' experiences in the classroom. As demonstrated in this study, when instructors decide to implement a flipped-classroom approach, more time is allocated for other instructional strategies to be implemented. Whether instructors decide to incorporate learner-centered activities is at their discretion; but as this study found, such pedagogical choices can significantly influence pre-service teachers' confidence in teaching. The purpose of this study was to determine whether a flipped approach to teaching a particular course makes a difference in measures of self-efficacy of two groups of students: one group whose instructor used a non-traditional, flipped approach to teaching (the experimental group), and another group (the control group) whose instructor used a traditional method of teaching. This study found with the flipped-classroom approach more time is available for students to demonstrate, explain, model, create, and analyze situations that are analogous to the experience of a classroom teacher. The flipped model circumvents the traditional teaching approach of expertise delivered from a professor and provides students with an opportunity to construct knowledge independently as well as collectively with their peers.

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Subject-Specific Teaching and Learning

Computer Science Graduates: Teaching Innovations, Earnings, and Reducing the Shortfall

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Abstract
Not enough students are signing up for computer science degrees to close the gap between job openings and applicants. This paper discusses (a) the process of choosing a career, (b) innovations that have been introduced into teaching to overcome student reluctance to pursue a "difficult" degree, and (c) three influencers of career choice. Job security and job satisfaction of computer science graduates are analyzed. The impact of computer science degrees on income is considered. The results show that National University's focus on working adults and accelerated learning is helping reduce the shortfall in the number of US computer science graduates.

Keywords: Computer science, innovative teaching, graduates, earnings, job satisfaction, job security, shortfall, job openings

Introduction

Lack of qualified candidates directly limits growth in the U.S. economy because of growth opportunities that cannot be addressed. One possible reason for the reluctance of students to study computer science is that prospective students are not aware of how good the job prospects are, in terms of both compensation and meaningful, satisfying work. Another important reason is the time required to get a degree—time that, for many, must be spent working now to earn the money needed for life's essentials. Many working in computer science and related fields are self-taught, but without a degree. Science requires specialized education and training and has a high potential for earnings.

This paper is based on a survey of 1,367 out of more than 3,500 computer science graduates who received their degrees over approximately 30 years at National University. With its focus on the working adult, National University makes a unique contribution to helping solve the shortfall in computer science graduates by offering a path for working adults to get computer science degrees, whether or not they have previous experience in programming or other areas related to computer science.

Greenstone and Looney (2011) reported that a "$102,000 investment in a four-year college yields a rate of return of 15.2 percent per year—more than double the average return over the last 60 years experienced in the stock market (6.8 percent), and more than five times the return to investments in corporate bonds (2.9 percent), gold (2.3 percent), long term government bonds (2.2 percent), or housing (0.4 percent)" (n.p.). This is an average across all college degrees. Based on the higher salaries earned by computer science graduates, as discussed in this paper, the return on investment is even better for a computer science degree.

Nevertheless, U.S. employers report a significant gap between the number of job applicants with computer science degrees and the number of graduates they are seeking to employ. Insufficient numbers of new students are signing up for computer science degrees to close the gap. There are not enough computer science graduates in the USA to fill all the jobs. This shortfall does not exist in most other areas of employment. The gap between numbers of people with the skills needed to fill the jobs and the number of open jobs is leading many employers to seek to hire from abroad. One source commented, ". . . programmers are desperately needed. It's tough to find the talent. Fewer than 2 percent of these types of experts are unemployed, so they are all in great demand, even CS majors just coming out of school" (Willmott, 2013, n.p.).

To better understand the issue of insufficient number of people choosing to study computer science, this paper starts with the criteria people often use in choosing an occupation. These typically start with an assessment of personal interest in a potential occupation, then an assessment of how hard it will be to become proficient in that occupation. If those tests are passed, people then go on to consider earnings (salary and benefits), job security, and job satisfaction.

Teaching Innovations to Foster Student Engagement

Nearly a quarter of a century ago, Krumboltz (1991), a Stanford professor, noted that "Many young people never make a career decision; they simply follow a path of least resistance. Summer jobs become permanent ones; family or friends pressure young people toward options that avoid temporary unemployment." This observation offers a partial explanation of why fewer people opt to enroll in computer science degrees than in other degrees. Studying computer science is not a path of least resistance.

In a 2013 blog, Stanford computer science student Singal (2013) commented, "Being a CS major is hard, which is probably why so many people don't do it. You'll doubt everyday whether you're meant for it, and will want to give up" (n.p.)." This may offer the best explanation behind the gap between number of computer science jobs and number of computer science graduates. Obtaining a degree in computer science may be more difficult than many other degrees. However, significant rewards await those who choose to study computer science, and those rewards help to overcome some of the resistance. The largest obstacle to students' choosing to study computer science is themselves. At the end of the aforementioned blog, Singal (2013) encouraged those considering a computer science degree with these thoughts: "Chances are if you just assume that you're not meant for it, you'll never be able to feel the thrill of getting something to work . . . , all because you're stopping you. Sometimes, the only one stopping you is you, and the answer is to just let go" (n.p.).

Because it is a difficult career field, the computer science program at National University is continually introducing innovations in teaching to foster student learning by simultaneously engaging several of the different learning styles described by Gardner (1983). Gardner's learning styles are summarized in Table 1.

The following four teaching innovations applied in the computer science program at National University are intended to foster student learning and engagement:

1. Interactive lectures available online for onsite and online students
2. Small-group presentations
3. Student-developed games
4. Circuit design and development using Multisim

Table 1. *Gardner's Learning Styles*

Learning Style	Description
Verbal/Linguistic	Highly developed auditory/word skills
Logical-Mathematical	Think conceptually and mathematically
Bodily-Kinesthetic	Excel at hands-on learning
Visual-Spatial	Learn through images and imagery
Musical	Especially sensitive to rhythm and sound
Interpersonal	Learn best through group activities
Intrapersonal	Learn best through individual study

Interactive Lectures

Absorbing orally presented material is a difficulty faced by everyone. Lectures are an important component of courses at National University, as they are at all institutions of higher learning. Typically, a series of PowerPoint® charts are presented and discussed so that students are engaged both visually and orally, addressing both the Verbal/Linguistic Learner and the Visual/Spatial Learner. The lectures also have built-in exercises that must be completed during the class, to engage the Logical/Mathematical Learner. However, once that lecture has been given, there is usually no way for the onsite student to listen to it again. The online student can listen to a recording of the entire session, but it can be difficult to locate a particular part of the lecture that they would like to listen to again. Sometimes, simple fatigue may cause a student to miss a key point. The student may not need to hear the whole lecture again, but would like to listen to a particular part of it. This is a need of the Intrapersonal Learner.

To meet this need, the computer science program has developed a complete set of narrated PowerPoint presentations with all the lecture material available to any student as an mp4 streaming audio. To enable students to focus on a particular topic, the lecture material has been broken up into a series of short segments which typically run 6 to 12 minutes in length. Whether students are taking the course on site or online, they can easily listen to a detailed narration of the particular topic as often as desired. These lecture segments are available through the university's Blackboard® Learning Management System, and the student can listen to them through any device that has an Internet connection, including computers, smartphones, and tablets. One recent student praised this approach, commenting, "This is how *all* online classes should be formatted. I love how all the PowerPoints are prerecords with audio that can be viewed whenever the students want. The class chats are more of a Cliff notes of the PowerPoints than the actual core of them. I can say this was one of the best classes I took."

Small Group Presentations

Student projects have long been used to engage Bodily/Kinesthetic Learners and Interpersonal Learners. It has been difficult to have effective student projects in online Computer Ethics courses. But, a way has been developed to enable small groups of students to work together asynchronously to analyze and then present their findings for a series of ethical dilemmas with which they are presented. The groups are presented with the dilemma, and then asked to analyze it jointly from the perspective of multiple ethical theories. Students can use group tools built into Blackboard or simply send emails to one another. Then students prepare individually narrated PowerPoint charts to present their findings and recommendations. Each student is required to provide at least one of the narrated charts. These narrated PowerPoint charts are then exported to an mp4 streaming video format and posted to Blackboard, where each student can listen to it. Finally, in the online classes, all students are required to discuss whether or not they agree with the findings of one of the small-group presentations in that week's online threaded discussions.

Students involved in the small-group presentations have found it to be an effective learning tool. One student commented:

> For our last presentation . . . I started out doing research on my own. I found real difficulty wrapping my head around the problem; it was much more complex . . . . When I met with my teammates, I proposed a new strategy which my teammates liked: We all researched the problem for a day on our own, and then came back to determine our course of action. When we met again, we all had a different aspect of the problem covered, including some ideas I would never have come up with. We arranged our topics in the order that felt the most appropriate, and then each person was responsible for their own topic, making slides and recording their presentations. Because everyone had contributed equally and found unique interesting points-of-view on the topic, our final presentation was also our strongest.

Student Developed Games

A third innovation that has been introduced into the Ethics course is the use of games. As with the previous innovation, this innovation engages the Bodily/Kinesthetic Learners, Logical-Mathematical Learners, and Interpersonal Learners. However, these are not packaged games developed by someone outside of the course; these are games designed and built by the students. Because of the National University accelerated learning format, they are simple games; but it has been found that having students develop the games requires them to engage at a significantly deeper level, particularly as they develop the game rules. The power and general effectiveness of student-designed games has been discussed by Jaurez, Fu, Uhlig, and Viswanathan (2010). Multiple graduates have praised this approach.

Circuit Design and Development Using Multisim

The final innovation used in the computer science program is the development of digital electronic circuits in the course on Digital Logic Design, which includes both theory and laboratory work using National Instruments Multisim. As noted at the National Instruments website, "Multisim software is used with low-cost student hardware platforms to reinforce theory and design advanced projects" and allows them "to complete electronics labs from basic Ohms law to advanced filters" (Multisim, 2015, n.p.). Multisim enables students to "develop sophisticated analog and digital systems for applications like robotics and controls" (Multisim, 2015, n.p.). In the laboratory component of the course, small groups of students are required to develop a series of digital electronic circuits and analyze their technical characteristics in detail. Once again, this approach particularly engages the Bodily/Kinesthetic Learner and the Interpersonal Learner.

The four teaching innovations used in the computer science program at National University in relation to Gardner's Learning Styles are summarized in Table 2. These four innovations are some that have been found to be effective in helping computer science students deal with the fact that "Sometimes, the only one stopping you is you, and the answer is to just let go" (Singal, 2013).

Table 2. *Relationship Between Teaching Innovations in Computer Science Program and Gardner's Learning Styles*

Teaching Innovation in Computer Science Program	Gardner's Learning Style
Interactive lectures available online for onsite and on line students	Verbal/Linguistic, Visual/Spatial, and Interpersonal Learner
Small-group presentations	Bodily-Kinesthetic, Logical-Mathematical, and Interpersonal Learner
Student-developed games	Bodily-Kinesthetic and Interpersonal Learner
Circuit design and development using Multisim	Bodily-Kinesthetic and Interpersonal Learner

Once students get past the initial fear of failure, they can go on to those considerations mentioned earlier that apply to all career paths: earnings (salary and benefits), job security, and job satisfaction.

There is increasing recognition that a college education is not the only immediate choice for high school graduates. Beard (2015) recently cited several reasons for not going to college, including the need to work now, and that not every job needs a degree. Beard noted that some "need to start working immediately after school, perhaps because they have bills to pay, they have family obligations, or college is just too far out of reach financially." Beard also noted that there are "jobs that pay well without a degree. The specific job requirements will depend on the company" and went on to mention several computer science related jobs (Beard, 2015).

A significant number of people who could be good candidates for a computer science education are self-taught programmers. One such person described five tips for learning programming on one's own as "1) Learn on the job, 2) Learn online, 3) Learn to overcome fear, 4) Learn by doing, and 5) Just go for it" (Levick, 2013. n.p.). Many working in computer science and related fields are self-taught, but without a degree.

It is not at all unusual for many people who fall into this category to reach a point in life where they are finally in a position financially to pursue a degree, and who have concluded that it will help them advance in their degree. With its focus on the working adult, National University has been designed for this kind of individual. This approach also makes a unique contribution to helping solve the shortfall in computer science graduates by offering a path for working adults, typically in their mid-30s, to get computer science degrees, whether or not they have previous experience in programming or other areas related to computer science.

Reasons for Choosing a Career in Computer Science

Based on results of a 2013 study, the Graduate Management Admission Council (2013) stated two “truths” that have remained constant for more than a decade: (a) the employability of graduates is excellent, and (b) graduates believe their degrees have played a significant role in advancement in their chosen careers, their ongoing professional development, and job satisfaction. The GMAC (2013) gave five reasons to get a graduate degree:

1. It can boost your career.
2. It is valuable.
3. It is a significant help in getting hired.
4. Earnings are better with the degree.
5. Employers are looking to hire people with a graduate business degree.

While the study was originally done for business graduates, the same five reasons apply to computer science graduates—both those with baccalaureate degrees and those with graduate degrees. The five reasons can be combined into the categories that were introduced above: (a) earnings (salary and benefits), (b) job security, and (c) job satisfaction.

Earnings (Salary and Benefits)

Jobs requiring computer science skills generally carry higher salaries than most jobs. In May 2013 the Bureau of Labor Statistics reported an average annual salary in the U.S. for computer positions of $81,860 for computer occupations. This is an average across all of the various areas in which a computer scientist can specialize. A number of specializations have average annual salaries greater than $100,000. For example, software developers, systems software specialists, earn an average salary of $104,480; computer and information research scientists earn an average salary of $109,260 (U.S. Department of Labor, Bureau of Labor Statistics, 2014). Microsoft’s senior policy counsel, based in Washington, DC, noted in February 2013 that Microsoft was seeking to hire 6,300 people, and more than half of those (3,600) required computer science and engineering skills. Those individuals could expect an annual salary of $100,000; however, benefits and the compensation brought the total to nearly $200,000 (Horn, 2013). All of these salaries are significantly more than the average annual salary of $46,900 earned by young adults between 25 and 34 years old with any bachelor’s degree, or $59,600 with any master’s degree or higher (U.S. Department of Education, 2015).

Job Security

There is significantly more demand for individuals with computer science degrees than the numbers of people who are graduating with these degrees. This is a trend that has continued for a number of years, with no clear solutions. An analysis done by Immedia Edu (n.d.) noted that “From the 2010–2012 report from the Bureau of Labor Statistics, http://www.bls.gov/, across all industries we are adding 136,620 jobs per year in computing. Subtract 40,000 annual computer science graduates . . . and you get roughly a gap of 100,000 jobs.” The same group forecasted that by the year 2020 there will be 1 million more computer science jobs than students, and they commented that this represents a $500 billion opportunity for students. They also noted that this growth rate is double the national average (Immedia Edu, n.d.).

In the same article, Immedia Edu commented, “According [to] the Conference Board, in October 2013 there were 570,000 computing job openings in the United States, making these jobs the highest demand in the US—about 4 times more than the US average” (Immedia Edu, n.d.). According to Willmott (2013), The US Bureau of Labor and Statistics noted that Mobile Application Development has the highest growth potential with 292,000 more jobs expected over the decade; and in the area of video game design, “over the next 10 years, the BLS predicts 30 percent job growth in the area, with 270,900 new positions being added.”

There is a serious shortage of workers not only in computer science but across all science, technology, engineering, and math (STEM) fields. In a recent *Wall Street Journal* article, Korn (2015) quoted Rothwell, a fellow at the Brookings Institution’s Metropolitan Policy Program, who said, “A shortage of skilled workers in sciences and engineering is more than just a headache for hiring managers . . . . Unable to fill key positions, firms can’t scale up to meet demand or deliver high-quality goods and services. It creates inefficiencies and slows down any economic progress.” (n.p.). In this same article, Korn commented that 34% of all bachelor’s degrees in 2014 were awarded in STEM fields compared with 33% in 2004. Korn also noted these figures reduce to 18% in 2014 and 17% in 2004, when social science and psychology were excluded from the STEM degrees (Korn, 2015).

The huge shortfall between the number of computer science graduates and the demand for these skills suggests a high level of job security. This does not make computer scientists immune from ever being laid off—particularly in startup companies. However, it does suggest that they should be able to find good-paying jobs with other organizations soon after leaving their previous employer, and should only be out of work for a short time. There is some unemployment among computer science graduates, but the rate of unemployment is lower than many other fields. Yankama (2015) reported an unemployment rate of 4.5% and decreasing for computer science alumni. These results covered many majors and were obtained from 22,815 alumni who took the survey.

It is also important that computer science graduates maintain their skills through lifelong learning. The technology is advancing rapidly and is expected to continue to advance for many years to come. One example is the well-known Moore’s Law. Originally, Moore’s Law simply stated that the number of transistors on a chip doubles roughly every two years. For the purposes of this paper, a more useful perspective is that the processing power of computers doubles roughly every two years.

Some fields of endeavor may change more slowly, but it is essential that computer science graduates keep up with advances. The following illustration hints at how important it is for computer science graduates to stay current in their field. The Industrial Age owed its advances to increases in speed of manufacturing brought about by the steam engine and electricity, and a tenfold improvement in transportation speed, moving from 5 to 7 miles per hour with horse-drawn carts, to 50 to 70 miles per hour for rail and truck transportation. The transportation infrastructure was also vital. These changes took place over approximately 150 years. However, advances in computer speed are taking place much more rapidly. Using Moore’s Law, the forecast change in computer processing speed is a factor of 75 rather than the factor of 10 improvement in the speed of moving physical goods during the Industrial Age. Each factor-of–10 increase brings major new applications of computer science. And graduates who do not keep up with the advances may find themselves obsolete and without a job sooner than others in fields that are not changing as rapidly.

Job Satisfaction

In their introduction to the 100 Best Jobs of 2015, the staff of *U.S. News & World Report* recently discussed job satisfaction as follows:

> The U.S. workforce has myriad talents, desires and lifestyles, so there is no one best job that suits each one of us. But if we were to define a good job generally, there are some unequivocal factors. The best jobs pay well. They challenge you without stressing you out too much. There's room to grow and advance. Maybe most importantly, the best jobs are ones that are hiring. From dentist, to accountant, to middle school teacher and civil engineer, the occupations on *U.S. News'* list of 100 Best Jobs of 2015 are ranked according to their ability to offer this elusive mix. (*U.S. News & World Report*, 2015, n.p.)

They went on to list three computer science categories among the Top Ten in their list of the 100 best jobs: Software Developer #3, Computer Systems Analyst #7, and Information Security Analyst #8.

Another source for measurement of job satisfaction was found in the surveys conducted by Yankama (2015) of *StudentsReview™*. One of the categories was "Job Satisfaction by major." The list showed percentages of graduates by major who were satisfied with their job. It also showed the percentage "who feel that things are generally going well." Yankama recognized some of the factors that impact these job satisfaction percentages, including the length of time since graduation, changes in career field after graduation, and the sample size of the surveys, and specifically noted that the surveys did not cover personal factors such as marital status, health, and similar personal matters (Yankama, 2015).

Computer science did not have the highest StudentsReview™ job satisfaction ranking, but it did have a ranking of 68.8%, which is slightly above the 65.1% job satisfaction ranking averaged across all majors. Computer science did better in the "going well" category, with a ranking of 76.6% versus an average ranking of 72.1% across all majors for the same category.

Some other indicators related to job satisfaction were also available in the StudentsReview™ survey results. The report showed an unemployment rate of 4.5% and decreasing for computer science graduates. This was not the lowest unemployment rate, but it was among the lowest and was significantly better than the average unemployment rate of 6.86% across all majors. A third measure related to job satisfaction is the percentage of graduates who are still in their field. The report noted that "students leave their 'field/major' for a number of reasons—usually insufficient salary, job satisfaction, or employment rates." "Insufficient salary" and "employment rates" could both be eliminated for Computer Science, leaving job satisfaction as the key indicator for this major. With the percentage of 80.9% "still in the field," computer science ranked fourth highest in a list of 76 majors surveyed. The only fields with a higher percentage included Pharmacy at 86.5%, Nursing at 83.8%, and PreVet and Veterinary at 81.8% (Yankama, 2015). Students also report high satisfaction with their learning experience. One student commented, "My problem solving skills have become immensely better after becoming a computer science major" (Singal, 2013).

Methodology

This paper is based on a survey of 1,367 out of more than 3,500 computer science graduates who received their Bachelor's and/or Master's degrees over approximately 30 years and since the BS degree began in 1982 at National University. The data used in this research study were based on the survey of computer science graduates of National University conducted in November and December 2014. A response rate of 10.9% (149 graduates) was received. Recipients of Bachelor of Science in Computer Science degrees comprised 91% of the responses, while 9.4% of the responses came from graduates who had received Master of Science in Computer Science degrees. Among the respondents, 39% came from graduates who had received their degree during the past 15 years, i.e., since 1999, and 60% of the responses came from graduates who received their degree before 1999. In addition, to gain a better understand the earnings and the impact of inflation rate on earnings, the inflation rate data were analyzed using the U.S. Inflation Calculator (2015).

The Results: Computer Science Graduates

All three of the factors—salary and benefits, job security and job satisfaction—are important, but this section of this paper focuses on earnings and employability of National University's computer science graduates. Total student loan debt in the United States has risen above total credit card debt. Questions have arisen from a number of quarters asking whether the cost of education is worth the investment for prospective students. Some claim that the high level of student loan debt has a negative impact on the economy, and that it prevents college graduates from spending on homes, cars, and other significant investments that have a major impact on the U.S. economy. Because computer science graduates are generally well compensated and unemployment is low for them, it would seem that these concerns should not apply to computer science graduates. To investigate whether this has been the case for National University computer science graduates, a survey was conducted of a sample of these graduates to gain some insight into how their jobs and their compensation changed after receiving their degrees.

A Fast Facts report of the National Center for Education Statistics (2014) gave a 2010 median salary of $29,900 for young adults with a high school diploma or its equivalent. The same report showed a small decline, year over year, for salaries of workers with a high school diploma or equivalent. An average annual salary of $30,000 for a high school graduate is used for comparison purposes throughout the remainder of this paper.

Averages and medians are important, but they do not reveal how salaries change after the receipt of a degree. Employers do not suddenly double employees' salaries when they receive a baccalaureate degree. Graduates may have to change employers to have the opportunity to earn a higher salary. In most cases they must change positions with their current employer to earn a higher salary. Some may not earn higher salaries as a result of receiving a degree. The analysis in this paper deals with averages. Individual experiences can and do vary widely.

Unlike traditional universities with baccalaureate students in the 18-to-25-year-old age group, National University focuses on higher education for the working adult. More than 3,500 alumni have Bachelor of Science and Master of Science degrees in computer science. National University students have an average age in the mid-30s, and they often have 5 to 10 years of work experience before beginning their studies.

A total of 84% of the graduates responded that their annual income increased as a result of obtaining their degree, while 16% indicated no increase in income. Among the graduates, 42% reported that their income increased less than 10% within the first year after they graduated, whereas 58% of the graduates indicated a corresponding increase of 10% or more. Relating to income increases during the first year after receiving their degree, 23% of the respondents reported an increase of between 10% and 20%. More than a third (35%) of the graduates reported increases of 20% or more during the first year after graduating, including 14% who reported increases of more than 40%. These data include all but two of the 149 respondents. Table 3 below provides more detail.

Table 3. *Percentage Income Increase within the First Year after Completing Degree*

Income Increase	**Number of Responses**	**Percentage of Respondents**
Less than 10%	62	42
10–20%	34	23
21–30%	18	12
31–40%	13	9
More than 40%	20	14
Total	147	100

The survey also asked graduates to estimate by what percentage their annual income had increased 5 years after they graduated and 10 years after graduation. These questions were answered by 144 of the 149 respondents. Increases of less than 20% after five years were reported by 28% of respondents, and 21% reported increases of less than 20% after 10 years. Inflation rates varied substantially each year during the many different 5-year periods covered by the survey. To gain a better understanding of the meaning of the data, an “Inflation Calculator” was used to compute actual 5-year inflation rates for the periods 1990–1994, 1995–1999, 2000–2004, 2005–2009, and 2010–2014. (U.S. Inflation Calculator, 2015). The results for those 5-year periods were 16.6%, 13%, 13.4%, and 11%, respectively. As a result, the survey data showed that more than 72% of the survey respondents’ income increases exceeded inflation, and more than 60% had increases more than double the 5-year inflation rates.

A similar calculation done for the 10-year periods 1990–2000, 1995–2005, 2000–2010, and 2004–2014 yielded 10-year inflation rates of 31.8%, 28.1%, 26.6%, and 25.3%, respectively. Tables 4 and 5 provide the details of percentage increase in income. A comparison of these data with the income increases shown in Table 5 indicates that approximately 70% of the survey respondents had income increases that exceeded inflation, and approximately half of them had income increases that were double the inflation rate. Among respondents, 24% reported that their annual income increased by more than 50% after 5 years, and 28% reported that their income had more than doubled after 10 years.

Table 4. *Percentage Income Increase Five Years after Completing Degree*

Income Increase	**Number of Responses**	**Percentage of Respondents**
Less than 20%	41	28
20–30%	29	20
31–40%	22	15
41–50%	17	12
More than 50%	35	24
Total	144	100

Table 5. *Percentage Income Increase Ten Years after Completing Degree*

Income Increase	**Number of Responses**	**Percentage of Respondents**
Less than 20%	30	21
20–30%	21	15
31–50%	28	19
51–100%	24	17
More than 100%	41	28
Total	144	100

Most National University students are working adults. All baccalaureate students have a high school degree. Graduate students have at least a Bachelor's degree. Some already have another Master's degree. Because they are usually already employed when they matriculate at National University, the survey asked about the job history of computer science graduates within the first 2 years after receiving their degrees, and then again during the 2- to 5-year period after graduation.

During the first 2 years, 26% of all of the respondents received a higher position at the same company, while 40% received a higher position at another company. Only about one-quarter stayed in the same position at the same company, while 5% became self-employed. Among respondents, 5% reported that their employment was intermittent or they had no job during the first 2 years after receiving their degree. Of those who received higher positions, 65% reported that their annual income increased by 10% or more with their promotion, and 13% reported that their income increased by more than 40% as a result of promotions during the first 2 years. Details are given in Tables 6 and 7.

Table 6. *Job History within the First Two Years after Receiving the Degree*

Job History	Number of Responses	Percentage of Respondents
Received a higher position at the same company	38	26
Received a higher position at a different company	59	40
Stayed in the same position at the same company	36	24
Became self-employed	7	5
Intermittent/No employment	8	5
Total	148	100

Table 7. *Income Change with Promotion*

Income Increase	Number of Responses	Percentage of Respondents
Less than 10%	49	35
10–20%	43	30
21–30%	22	16
31–40%	9	6
More than 40%	18	13
Total	141	100

The percentages of graduates who had been promoted to a higher position at the same company or at another company remained exactly the same. The percentages that stayed in the same position within the same company also remained the same during the 2- to 5-year period. The number of individuals who were self-employed increased to 6%. The number whose employment was intermittent or who had no job during this 2- to 5-year period after graduation remained at the same 5% that reported no job or intermittent employment 2 years after graduating.

The final survey question asked graduates about their expectations of the lifelong financial impact of their degree on their income. This question was answered by 134 of the total 147 respondents. Among those answering, 45% expected to earn twice what they were earning without their degree. More than one third of the respondents to this question expected to earn five times more, while 19% expected to earn ten times greater or more. These results are shown in Table 8.

Table 8. *Expectation of the Lifelong Financial Impact of Degree on Income*

Impact Expectations	Number of Responses	Percentage of Respondents
I expect to earn twice what I was earning before obtaining my degree	60	45
I expect to earn five times more income as a result of my degree	48	36
I expect to earn ten times more income as a result of my degree	18	13
I expect to earn fifteen times more income as a result of my degree	8	6
Total	134	100

The review of previous research revealed that similar studies were conducted on 2-year and 4-year colleges and universities in Virginia and Tennessee. These studies compared the average first-year earnings of recent graduates and explored the variation in earnings for graduates from individual degree programs at individual colleges.

For the study related to the colleges and universities in Tennessee, the findings revealed that in general, graduates with bachelor's degrees in health, business, and engineering earned more than graduates with liberal arts degrees (Schneider, Massa and Vivari, n.d.).

For the study related to the colleges and universities in Virginia, the findings revealed that substantial variation existed in the early-career earnings of students from different programs and different degree levels across the commonwealth (Schneider et al., n.d.).

In both the studies, the results showed that the degrees students earned, and where they earned them, mattered. Similarly, our research findings showed that the type of degree, i.e., computer science or business administration, do matter. However, our research study went beyond 1 year and evaluated 5-year and 10-year results, whereas the Virginia and Tennessee studies focused only on 1-year earnings of the graduates.

Conclusions

Four teaching innovations that have been introduced into the National University Computer Science programs are related to the learning styles identified by Gardner. These teaching innovations help students get through the fact that learning computer science is hard.

Three criteria for choosing a degree in computer science were investigated: (a) earnings (salary and benefits), (b) job security, and (c) job satisfaction. All three criteria show that computer science is a good choice. Salary and benefits are excellent. High demand for computer science graduates, accompanied by low unemployment rates, indicates a very good level of job security. Finally, job satisfaction is also very good for those who have the inclination to study computer science.

In a survey of National University Computer Science graduates conducted in November–December 2014, 84% responded that their annual income had increased as a result of obtaining their degree. Two thirds of the respondents received a higher position at the same or another employer within 2 years after receiving their degree.

The distribution of income increases 5 years after graduation and 10 years after graduation for computer science graduates has a dip in the 20% to 40% range. The data would seem to indicate that those computer science graduates who move up tend to move to higher salaries relatively quickly. Whether looking at the 5-year data or the 10-year data, approximately 70% of the respondents reported income increases that exceeded inflation rates, and a high percentage had income increases more than double inflation rates.

The survey results showed that these graduates are successful in their careers. National University's focus on working adults and accelerated learning has resulted in 3,500 computer science graduates since 1985 who would not otherwise be there. Although 3,500 is a relatively small number compared to the total shortfall in computer science graduates, it is helping to reduce the shortfall.

Many computer science students changed companies to receive a higher position after receiving their degree, indicating that computer science students were mobile as a result of obtaining their degree. Computer science graduates surveyed had a high expectation of increased lifetime earnings as a result of obtaining their degree.

Obtaining a computer science degree requires hard work. It is perceived by many potential students as requiring more effort than many other career choices. Fear concerning the level of effort required may be the deciding factor that prevents potential students from exploring the benefits associated with earnings, job security, and job satisfaction when they are choosing a major.

The degree is not a guarantee of employment. There is a persistent factor of 5% of graduates who do not obtain better jobs or receive higher earnings. Individual drive and motivation will be the best determinants of success, whether in computer science or any other field of study.

Observations, Discussions, and Suggestions for Future Research

The scope of this paper is limited to the relationship between earnings (salary and benefits), job security, and job satisfaction for computer science graduates within the United States. Therefore, although the conclusions hold true in a developed nation such as the USA, in the less developed and the developing nations, the earnings, job security, and job satisfaction are strongly influenced by various other factors such as population size, number of graduates in a particular field of study such as computer science, unemployment rate, number of job openings, inflation rates, globalization and movement of skilled labor, advances in technology, and cultural values and norms. The opinions, discussion, and suggestions for future research pertaining to these factors are presented next.

For example, one may argue that developing nations such as India and China are experiencing a surge in growth in their technology sectors, resulting in a rise in employment opportunities for computer science graduates. On the other hand, others may argue that the rise in employment opportunities in the technology sectors in these nations is proportionately less than the growth in the number of graduates in computer science. Accordingly, one might argue that the supply for computer science graduates in these two developing nations is greater than the demand. Furthermore, an argument might be made that, every year, the population growth is disproportionately adding to the overall unemployment rate, and specifically to the number of computer science graduates, vis a vis the growth in employment opportunities in the technology sectors in these nations.

Therefore, to understand the relationship between a particular field of study (such as a degree in computer science) and the earnings, job security, and job satisfaction in the developing and less developed nations, the authors of this paper suggest that future research endeavors include such intervening variables as population size, number of graduates in a particular field of study, unemployment rate, and number of job openings in these nations.

The relationship between a particular field of study (such as a degree in computer science) and the earnings, job security, and job satisfaction is further complicated with the rise in globalization, decreasing restrictions on the movement of skilled labor across nations, and the advances in technology. As a result of such intervening factors, the high number of job openings, or lack thereof, in one country or region are offset by the number of, demand for, or shortfall of graduates in another country or region, which, in turn, may skew the impact on earnings, job security, and job satisfaction in both the developing and less developed nations. For example, one might argue that when presented with an employment opportunity in a developed nation, either physically or remotely through the advances in technologies, the impacts on earnings, job security, and job satisfaction are positive in India and China for a computer science graduate, when compared to other graduates without such an employment opportunity. On the other hand, others might argue that such an influx of computer science graduates from the developing and less developed nations into the labor force in technology sectors of the developed nations might skew the impact on earnings, job security, and job satisfaction of a computer science graduate in the latter nations.

Therefore, to understand the relationship between a particular field of study (such as a degree in computer science) and the earnings, job security, and job satisfaction in the developing and less developed nations, the present authors suggest that future research endeavors include such intervening variables as the globalization and movement of skilled labor, advances in technology, number of graduates in a particular field of study, and number of job openings in such nations.

The relationship between earnings (salary and benefits), job security, and job satisfaction for computer science graduates in the developed nations and less developed or developing nations is different due to the strong influence of inflation rates. Generally, inflation rates are higher in the less developed and developing nations than in the developed countries. Therefore, the higher inflation rates have adverse impact on the earnings of the graduates in the less developed and developing nations, more so than in the developed nations. Therefore, to understand the relationships between the earnings, job security, and job satisfaction of the computer science graduates in the developing and less developed vs. developed nations, the present authors suggest that future research endeavors include the intervening variable of inflation rates in these nations.

Furthermore, some may argue that, in general, in the USA and other developed nations, higher education is primarily valued in monetary terms and cultural values, and norms do not play a significant role. This might be especially true for computer science graduates. Furthermore, several cultural norms, such as pursuit of higher education as a "working adult" and high rate of mobility or geographical relocation for employment, may skew the impact on earnings, job security, and job satisfaction in the USA and other developed nations. However, the developed, developing, and less developed nations share a similar cultural value—obtaining a degree in computer science is difficult.

On the other hand, others may argue that in the less developed and developing nations, higher education is equally valued in monetary and intangible benefits, the later embedded in cultural values and norms. For example, in India and China, higher education is respected, honored, and associated with hard work, elitist status, prestige in the community, and job security (Uhlig, Mehta, Silverstone, & Mossavar-Rahmani, 2015). One may argue that the hard work, elitist status, prestige, and job security are especially true with computer science. As a result, some may argue that in these nations, a computer science degree is often preferred in spite of lower earnings over other degrees, due to cultural values and norms. In addition, several cultural norms, such as pursuit of higher education prior to entering the professional workforce and not as a "working adult" and the lack of mobility or geographical relocation for employment, may skew the impact on earnings, job security, and job satisfaction in India, China, and other developing and less developed nations. Therefore, comparative research is recommended to examine the relationship between cultural values and norms and the earnings, job security, and job satisfaction in the developing and less developed nations.

Finally, obtaining a degree in either computer science or any other field is not a guarantee of either positive or negative earnings, job security, and job satisfaction. One might wonder about the impact of a specific field of study such as computer science on earnings, job security, and job satisfaction in the developed nations compared to the less developed or developing nations. Do the population size, intellectual competence of the people, and peoples' zest to succeed generate stiff competition within and between the developed and developing or less developed nations? What is the impact of such factors on the earnings, job security, and job satisfaction for computer science in the developed, developing and less developed nations? One may assume that in India and China, with the surge in growth of the technology sector and the associated employment opportunities, one might pursue higher education in computer science in order to remain competitive and marketable; and yet the overall impact of this degree on earnings, job security, and job satisfaction might not be as positive as in a developed nation such as the United States. Further research to study the relationship between and impact among such factors is recommended.

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Course Redesign of Online Non-Majors Biology: Analysis of Effects

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Abstract
We redesigned an online non-majors General Biology course (Survey to Biosciences, BIO100) by implementing a number of Constructivist and active learning approaches, and selecting a new textbook. Thirty courses before and thirty courses after the redesign were analyzed for student survey results, BIO100 and the corresponding Survey to Biosciences Laboratory (BIO100A) course grades, as well as the influence of student demographics such as age and ethnicity. Official end-of-class surveys scores of student perceptions of teaching, learning, and course content were compared pre- and post-redesign. We found that in the surveys only the perception of the textbook was significantly improved after redesign. Additionally, no difference was found in survey scores between the thirteen instructors teaching the course. No significant changes were found in either BIO100 or BIO100A grades after the redesign. BIO100A grades were strongly associated with BIO100 grades. Strong relationships were found between certain student demographic groups and BIO100A course grades, as well as between course enrollment and attrition.

Keywords
Science education, course design, constructivism, active learning

Introduction

The U.S. faces the great challenge to improve undergraduate science, technology, engineering, and mathematics (STEM) education. Numerous studies have shown the inadequacy of most college level science courses for the development of critical thinking skills necessary not only for scientists, but also the population at large; as well as a troubling exodus of undergraduate students from STEM majors. In 2012, the “Engage to Excel” report to the President of the U.S addressed these issues, and included a number of recommendations to increase student retention in STEM disciplines (President’s Council of Advisors on Science and Technology, 2012). Several of the recommendations were based on the results of evidence-based, innovative pedagogies in science education that have been gaining momentum over the past years, including a steady push to move from traditional lecturing towards more active approaches, and a broader awareness of pedagogical principles. Moreover, the increased institutional requirements regarding assessment have moved educators to reflect and evaluate their own teaching practices more systematically.

In Biology, instructors often apply novel learning approaches or redesign courses based on overarching frameworks such as the Association of American Colleges & Universities (AACU) Value Rubrics (Rhodes, 2010), or the Vision and Change Report (American Association for the Advancement of Science, 2011). Recent analyses claim that the movement towards innovative pedagogies and student centered approaches seems to have reached a tipping point as shown by a growing number of educational initiatives promoting practices such as undergraduate research and peer and problem-based learning among others (American Association for Advancement of Science, 2015; Bradforth et al., 2015).

On the other hand, implementation of such pedagogies including the very definition of their success is a complex and demanding process. While there are a number of documented studies of carefully designed, implemented, and assessed interventions in science education, those success stories are harder to achieve "in the trenches" (D’Avanzo, 2013). In addition, particularly at research universities, teaching excellency is not rewarded as highly as research activities, thus scholarly work regarding pedagogy is limited (Anderson et al., 2011).

In 2000, Pat Hutchings defined a variety of aspects to consider in the scholarship of teaching and learning such as the questions of "*what works*" and "*what is*" as well as exploring "*visions of the possible*" (Hutchings, 2000). These aspects summarize the levels of complexity when researching the teaching and learning process, from the very practical (designing approaches and comparing their effectiveness) to the exploration of metacognitive aspects for both students and faculty, and developing complex educational frameworks.

It is important to distinguish between teaching effectiveness, student learning, and student perception of learning. The first can be often associated with pre-established goals, such as the reaching of certain scores in standard testing. The true measure of student learning, however, is dynamic and hard to define. Student learning is often evaluated through completion of assignments addressing either required content or skills, and it is usually expressed as some type of score or grade. While students may improve their exam scores or specific skills after a teaching intervention, this improvement does not always correlate with long-term learning and/or retention (Darland & Carmichael, 2012; Shaffer et al., 2014). Lastly, student perception of learning is tainted by a number of biases and emotional-metacognitive aspects. As scholarly works in the field of teaching have shown, only a very rigorous and triangulated (using more than one measure) approach can truly reveal what is going on inside the students' learning process (Hill, Brözel, & Heiberger, 2014; Stanton, Neider, Gallegos, & Clark, 2015; Trujillo & Tanner, 2014). In contrast to laboratory sciences, where it is often possible to have tightly controlled experimental and control populations of nearly identical subjects, this is not possible in a classroom (Rowland & Myatt, 2014). This fact makes the design and evaluation of educational research studies more challenging, however if done rigorously, they can provide rich and nuanced answers.

In the present article we describe the case of the course redesign of a high enrollment non-majors general biology course taught by multiple instructors at a private non-profit West Coast university specialized in accelerated learning. BIO100 (Survey of Biosciences) and its laboratory counterpart, BIO100A (Survey of Biosciences Laboratory), are often the only science courses taken by General Education (GE) students. BIO100 courses are offered both onsite and online; our study focused exclusively on the online sections. In the end of course evaluations before the course redesign students repeatedly complained of high workload and the difficulty of the material. This is typical of introductory courses, as the array of new ideas and unfamiliar terminology tend to overwhelm students, resulting in memorization of facts without understanding the underlying common principles (Chi, 2005; diSessa, 1993).

The course was redesigned in 2013, 1) to address repeated instructor complaints about plagiarism, and 2) to incorporate instructional models based on learning theories in order to facilitate student learning. To address the issue of plagiarism, exams containing randomized questions were implemented, and more varied assessments were introduced. The two learning theories chosen to support the redesign of the course were Cognitivism and Constructivism. In Cognitivism knowledge acquisition is described as a mental activity that entails internal coding and structuring by the learner, with emphasis on the building blocks of knowledge e.g. identifying prerequisite relationships of content (Dabbagh, n.d.). Constructivist theory is based on the idea that people construct their own understanding and knowledge of the world through experiencing it and reflecting on those experiences (Harasim, 2012). Currently much emphasis is placed on the acquisition of 21st Century Skills, a set of abilities that students need to develop in order to succeed in the information age (Thoughtful Learning, 2015). A thread that runs through the skills and abilities list is the learner taking control and being engaged in the learning, with emphasis on development of critical thinking skills (Nagle, 2013).

We based our course design on general Constructivist principles advocating for active learning helped by frequent feedback and low-stakes assessments. These principles have been validated as critical for quality biology education (Allen & Tanner, 2005; Armbruster, Patel, Johnson, & Weiss, 2009; Freeman et al., 2014; Freeman et al., 2007; Haak, HilleRisLambers, Pitre, & Freeman, 2011; Nomme & Birol, 2013); moreover, they are essential for accelerated courses (Scott, 2003). Adaptive quizzes and other practice assessments provided multiple opportunities for students to reinforce their learning, while scaffolded assignments allowed for rich instructor feedback, as students mastered the material. In addition, we incorporated weekly surveys addressing student perceptions of the difficulty of the materials, with the opportunity for open-ended comments to early detection of potential problems.

Our predictions were that the redesign would result in 1) improved student perception of teaching, learning, and course content, and 2) better preparation of students manifesting in better grades for both BIO100 and the subsequent BIO100A courses (student learning). First, we describe the process of redesign based on scientific teaching principles and established learning theories, then we present a thorough statistical analysis where we contrasted commonly used measures of evaluating student learning and perception of learning before and after the intervention. These included grades and student survey responses, respectively. We also evaluated if specific demographic populations of students responded differently to the course redesign, and if the redesign affected class attrition.

Materials & Methods

Courses

BIO100 together with BIO100A, are non-majors general biology courses part of the GE curriculum. BIO100 is taught both onsite and online, with online enrollment much higher than onsite (**Fig.1**). Our study included the online sections only. BIO100 covers the scope of biology starting with the scientific process; a review of biochemistry, cell biology, basic genetics and molecular biology, and evolution; a survey of living organisms, as well as basic concepts in ecology and biodiversity. The complete list of course learning objectives can be found in Appendix A.

Thirty courses taught by thirteen different instructors before and after the course redesign (total of sixty), were sampled in the period between April 2012 and December 2014, with the redesigned courses starting in August 2013. Class sizes ranged between 22-39 (average 29) pre-, and 18-35 (average 26) post-redesign. Of the thirteen instructors, two taught most of the courses (6 and 9 pre-, and 6 and 14 post-redesign, respectively), while the other instructors taught 1-4 courses each.

Course redesign

The previous course design included reading assignments and static PowerPoint lecture slides, and assessed students via a midterm and a final exam, as well as written reports based on online videos and other materials. As the course content had not changed significantly in over 5 years, recurring instructor and student complaints included the presence of plagiarized reports and exams on the Internet. Moreover, students perceived the course as very hard and with a heavy workload.

The overall ADDIE (Analyze, Design, Develop, Implement, Assess) approach for instructional design was used (Branch, 2010). For the redesign we decided to follow general Constructivist principles by offering a blend of formative and summative assessments, as well as promoting scaffolded assignments. We chose a textbook (Phelan, What is life?) that provided a colorful and easy to read content, as well as electronic assets such as a rich set of adaptive online quizzes and a large customizable test bank containing questions spanning all Bloom's Taxonomy levels (Crowe, Dirks, & Wenderoth, 2008).

In addition, to increase dynamic interactions in the course and collect early feedback from students, weekly synchronous videoconference sessions via ClassLivePro (CLP) were held, and short weekly surveys collected via Google Forms. The surveys addressed students' perceptions of the content and difficulty of the weekly material, with space for comments. **Table 1** summarizes the differences between the design of the old and the new course design.

Measures

We collected data from sixty end-of-course surveys. These surveys are deployed to students during the last week of the course but before the final exam. **Table 2** shows the questions included in the surveys. We compared survey results both at the individual question level and in three aggregated categories (learning, teaching, and course content; see the Statistical Methods section below).

Enrollment and attrition data were obtained through National University (NU) online course management system. The NU Office of Institutional Research and Effectiveness provided the student demographic data and the matched BIO100 and BIO100A grades, without identifiers.

Statistical methods

Demographic data were collected regarding 1,315 students' age, self-identified ethnicity, and grades for BIO100 and BIO100A. For analyses that used age and ethnicity as covariates, designations with less than 30 individuals were removed from subsequent analyses due to low sample size.

Student end-of-course survey responses were averaged per class per question, as well as across three categories: student perception of learning, student perception of teaching, and student perception of course content. Wilcoxon signed-rank tests were performed to analyze pre- and post survey scores. Effect of instructors on survey scores was evaluated using a MANOVA with Pillai's trace.

To test if the course redesign had a significant effect on a students' grade in BIO100 or in the following lab course, BIO100A, while controlling for variance due to other factors, we used an analysis of covariance (ANCOVA). This allowed us to control for age and ethnicity, and when BIO100A grade was the dependent variable, to test whether a student's score was affected by their grade in BIO100. To test the effect of course design and class size on attrition, we performed a multiple regression analysis of attrition against original enrollment and course design (pre- vs. post-intervention). Wilcoxon signed-rank tests were performed to analyze withdrawals pre- and post- intervention. Statistical tests were performed using JMP 11.0.0 (SAS

Institute). Figures were produced using Prism version 6.00 for Mac, GraphPad Software, (La Jolla CA, www.graphpad.com) and ggplot2 (Wickham, 2009) in RStudio (RStudio Team, 2015).

Results

Student demographics

Demographic data of are shown in **Table 3**. The mean student age was 34, with a range of 19-69.

No difference in student perception of teaching, learning, and course content

Survey results of 30 courses each pre- and post-intervention were compared. Survey answer rate ranged between 19.05% and 80.77% per course (mean 47.08%, N=60).

Figure 2 shows the results of the comparison. Means pre- and post- intervention for learning, teaching, and course content were 3.96-3.98, 4.23-4.24, and 4.07-4.17, respectively. While there are small increases in student perceptions, these differences were not significant. However, at the individual question level, the statement "Textbook helped me achieve the course learning outcomes" rated significantly higher for the post redesign group (Wilcoxon signed-rank, $Z = 2.38$, $p = 0.0175$). The average end or course survey response to student perceptions of learning, teaching, and course content did not vary significantly by instructor (MANOVA with Pillai's trace; $F = 1.463$, $p = 0.064$).

BIO100 grades strongly predict BIO100A grades, with no significant difference pre- and post-redesign

After removing demographic categories with less than 30 individuals (non-resident alien, Native Hawaiian/Pacific Islander and American Indian/Native Alaskan) as well as "decline to answer," 1291 individuals who had taken both BIO100 and BIO100A remained for further analysis. ANCOVA analysis showed BIO100 and BIO100A grades were strongly correlated, and older students earned significantly higher BIO100A grades. On the other hand, after statistically controlling for variance due to a student's grade in BIO100, age and ethnicity, the effect of the course intervention on students' BIO100A grades was not significant (see **Table 4**). This lack of effect was also found pre- and post-intervention for BIO100 when controlling for age and ethnicity (ANCOVA, see **Table 5**).

Students who identified as Black or African American received significantly lower grades in both BIO100 and BIO100A than any other group tested **(Figure 3).**

Initial enrollment correlates with attrition

We wanted to know if course withdrawals (often correlating to initial difficulties with course material, as well as workload perceived as excessive) had decreased after the course redesign. We did not find a significant change in the number of course withdrawals (Wilcoxon signed rank; $Z = 0.878$, $p = 0.380$). We looked at the overall effect of the course enrollment and course design to attrition. Attrition is significantly affected by class size, but not by the course intervention (Multiple regression: overall test $r2 = 0.1631$, $p = 0.0063$; **Table 6** and **Figure 4**).

Discussion

In a classic work, Randy Bass defined the starting point of teaching scholarship as identifying "the problem," e.g. the issue we struggle with in our classes, be it low student evaluations or high attrition. From there, educators can go on the scholarly activity of studying and improving their teaching practices from the perspective of student learning, one approach or aspect at a time (Bass, 2009). In our case, "the problem" was many-fold: a high enrollment online non-majors biology course was plagued by instructor and student complaints, mainly centered on plagiarism and perceived high workload. Both issues were addressed through a combination of resources and a course design based on learning theory principles.

First of all we chose a textbook particularly well suited for non-majors (easy to read, with plenty of real-life examples) that also provided a number of supplementary assets.

An extensive and customizable question bank provided the basis to set up randomized exams, which solved the issue with exam plagiarism. Since the course redesign in August 2013 to the present (2015), no exam plagiarism complaints have been officially reported. A set of game-like adaptive quizzes that provide hints and feedback to students was instituted as a low stakes assignment/homework, which provided three benefits: a) student active learning and practice, b) freeing time for instructors to spend on more meaningful interactions with students, and c) a dashboard for instructors to monitor students' performance and most common misconceptions. Digital dashboards have been used to improve the feedback cycle and to inform instructors about student learning (Brown, Lovett, Bajzek, & Burnette, 2006). That way, instructors can intervene by supporting struggling students and/or actively addressing misconceptions. Emphasis was also given to scaffolded assignments such as written reports, developed in parts with plenty of feedback. To provide students with multiple opportunities to interact with the material, lectures were professionally recorded and included in the course, together with the lecture slides. Finally, more opportunities for interaction and student feedback were instituted by using synchronous chat or video conferencing and informal weekly surveys.

In most academic settings teaching innovation takes place continuously when instructors "try out" approaches they learn about and often evaluate their success based on anecdotal evidence. However, at the practical level, teaching effectiveness is commonly assessed through student surveys. While a number of works have clearly shown the lack of reliability of student surveys as a measure of teaching and learning (Boysen, Kelly, Raesly, & Casner, 2013; Stark & Freishtat, 2014), they are still the main way that instructors are evaluated for a number of important decisions such as rehire, promotion, and tenure.

We hypothesized that the course redesign would result in improved student perceptions of the three aggregated categories of teaching, learning, and course content in the official end of course surveys. While student perceptions increased slightly for all three aspects, the increase was not statistically significant. We do not know if a number of technical difficulties plaguing the implementation of the new design had any influence on the results. When analyzed at the individual question level, however, students had a significantly better perception of the textbook, a fact supported by numerous positive comments in the weekly surveys (results not shown).

One of the main criticisms of student surveys is the low rate of participation. For BIO100, the response rate for the end of course surveys ranged between 19.05% and 80.77%. While anecdotal evidence points to higher response rates when students are unhappy with the instructor, we could not observe significant differences between the survey results of courses taught by 13 different instructors. It is noteworthy that the weekly survey participation rate was highest during the first week of class, highlighting the importance of prompt feedback to advise students and respond to their questions (results not shown). Moreover, instructors can make adjustments to their teaching during the course instead of needing to wait for the results of the end of the course surveys.

Another metric we were interested in was if the redesigned BIO100 course prepared students better for the BIO100A laboratory course, which is taken after BIO100. We observed a very high correlation in students' BIO100 and BIO100A grades, which could reflect both biology preparation and college skills. However, we could not see significant improvement in BIO100A grades after the BIO100 redesign. Some authors do not consider grades as a reliable measure of student learning (Schinske & Tanner, 2014), or it could be that completion of BIO100 does not provide the skills that allow a better performance in BIO100A. The issue is further complicated by the fact that not all students take BIO100A immediately after BIO100. This is an aspect that requires deeper exploration within a more controlled design.

The presence of an older student population and a large proportion of minority students underscores the non-traditional characteristic of the university's student body. It has been described that active learning approaches and more structured classroom teaching disproportionally benefit certain demographic populations such as Blacks/African-Americans, Hispanics, or first generation college students (Eddy & Hogan, 2014; Freeman et al., 2007; Haak et al., 2011). We explored if there were differences in BIO100 and BIO100A grades between demographic groups, and if there was any significant change pre and post course redesign. Two clear associations with demographics were found: older students earned better BIO100A grades, and Black/African American students had significantly lower BIO100 and BIO100A grades. While there was an improvement in BIO100A grades after the BIO100 course intervention for Black/African American and Asian students, those effects were not statistically significant. It would be of interest to explore which specific active learning activities benefit these student populations the most. The correlation of age with better grades in the BIO100A, but not the BIO100 course is intriguing. It could be hypothesized that the hands-on character of BIO100A, together with its structured writing assignments (laboratory reports) may be easier for older, more professional students.

Finally, we wanted to address if the course intervention had decreased attrition in class. While we could not see a difference in the number of students dropping the class after the redesign, we could still see a clear correlation between original class size and attrition, with more students dropping in the classes with the highest enrollments. This supports the case for limiting the number of students in class.

In summary, our original hypothesis that the course redesign would result in significantly higher scores of student perception of teaching and learning was not supported. However, students rated the new textbook significantly higher, and the weekly informal surveys consistently showed that while students considered the material difficult, they still perceived it as "appropriate." Moreover, comments about the adaptive quizzes and other active course features were overwhelmingly positive. Many of these features are self-graded by the textbook companion site, providing instant feedback and hints to students, as well as giving instructors 1) a dashboard of students and topics with the most difficulties and 2) time released from grading that instructors can dedicate to interactions with students and improved teaching practices.

Nomme and Birol (2013) described the redesign of a non-majors biology course over a period of two years, systematically assessing student learning and attitudes towards science with a broad range of quantitative and qualitative methods. Recently, Erin Dolan has called for a targeted approach to biology education research specifically addressing "how to select the right tools for the job, how to use the tools, and what latitude there is for using a range of tools" (Dolan, 2015). As a continuation of this project we intend to implement more stringent and telling measures of student learning. These will include open-ended questions in the final exams addressing higher Bloom's levels of learning that can be assessed both quantitatively and qualitatively.

Following on Randy Bass' lead we see this study as one point in the process of improvement of our teaching practices for non-majors general biology, and intend to keep documenting the process with improved analytic tools. Based on our experience, we encourage educators to develop a comprehensive assessment plan in advance of major teaching interventions, including "pre" or "control" measurements, in order to be able to objectively evaluate the impact of the intervention.

The scholarship of teaching and learning has been described as involving not only the systematic study of teaching and/or learning but also its public sharing and review of such work through presentations, performance, or publications (Mckinney, 2006). We hope that our results will encourage others to not only embrace novel teaching approaches in science education, but also to explore and share the observable and quantifiable data resulting from such endeavors.

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Appendix A Course Learning Objectives for BIO100

1. Apply hypothesis formulation and hypothesis testing by the scientific method
2. Describe the structure and cellular function of biologically important molecules, including carbohydrates, lipids, proteins, and nucleic acids
3. Compare and contrast prokaryotic and eukaryotic cellular structures and organelles (e.g., cellular membrane, nucleus, mitochondria)
4. Describe cellular functions related to metabolism, communication, and growth
5. Compare and contrast the classification, fundamental cellular structure, body structure, and physiology of the different kingdoms of multicellular organisms
6. Explain fundamental concepts of population ecology, community ecology, and ecosystem ecology
7. Explain evolutionary processes, including natural selection, speciation, extinction, and the origin and history of life on Earth

Appendix B Figures and tables

Figure 1.

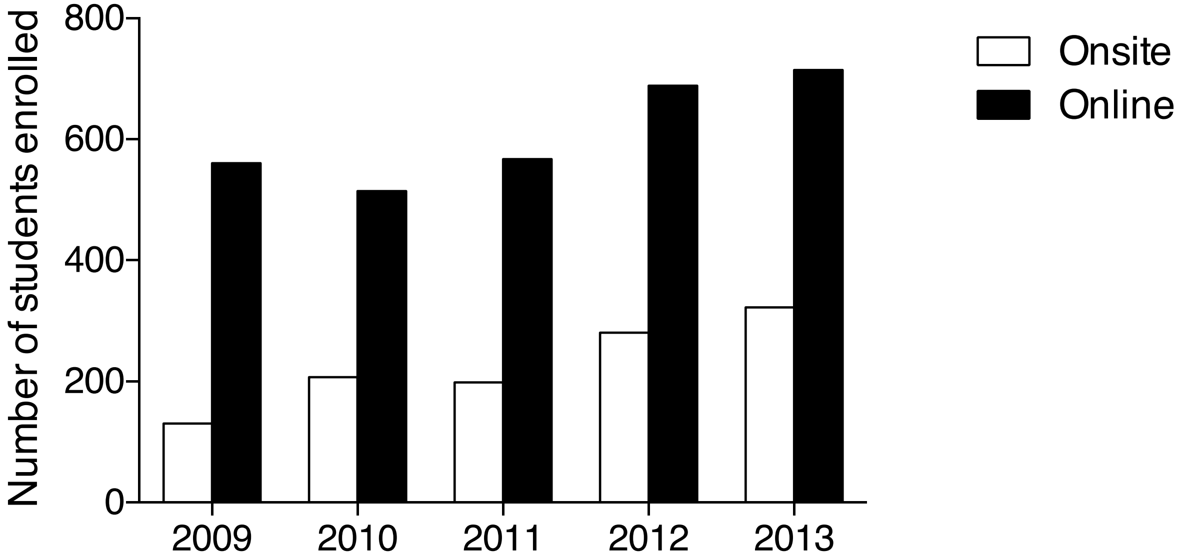

Figure 1. Student enrollment in BIO100 courses, covering academic years 2009-2013 (July-June). Online enrollment was consistently higher than onsite enrollment.

Table 1. *Comparison of the BIO100 Course Design Before and After the Intervention*

Component	Course item pre-redesign	Course item post-redesign
Icebreaker	Introductions	Introductions
Formative Assessment	Weekly Discussion Board (DB) posting	Adaptive quizzes Weekly DB posting Practice quizzes
Summative assessment	Midterm exam (set questions) Final exam (set questions) Written assignment (guided report)	Midterm exam (randomized from testbank) Final exam (randomized from testbank) Written assignment (report/poster)
Audiovisual	Static Powerpoint slides Videos & animations	Static Powerpoint slides Recorded lectures Videos & animations

Personal interactions	Weekly text chat Email	Weekly videoconference Email
Assessment of student satisfaction	Final survey	Weekly survey Final survey

Table 2. *Summary of End of Course Evaluation Questions*

	NU Student Survey Questions
Student Self-Assessment of Learning	My writing skills have improved. My oral communication skills have improved. My computer skills have improved. I gained significant knowledge about this subject. My ability to do research has improved. My ability to think critically about topics in this class has improved. I can apply what I learned in this course beyond the classroom.
Assessment of Teaching	Instruction was well organized. Content areas described in the course outline were covered. Method of assigning grades was clear. Instructor gave clear explanations. Instructor was receptive to questions. Instructor stimulated critical thinking. Instructor encouraged students to think independently. Instructor was available for assistance. Instructor provided timely feedback on my work. Instructor provided useful comments on my work. The instructor was an active participant in this class. Threaded discussions were useful. Chat sessions were useful. Grades were posted to the gradebook in a timely manner. Instructor responded promptly to emails and other communications. Overall, the instructor was an effective teacher.
Assessment of Content	Class activities helped me achieve the course learning outcomes. Textbook helped me achieve the course learning outcomes. Supplemental materials helped me achieve learning outcomes.

Table 3. *Student Demographics (N= 1,315)*

Student Self-Reported Ethnicity	**Count**	**Percent**
White	615	46.77
Hispanic	339	25.78
Black or African American	152	11.56
Elected not to respond	74	5.63
Asian	57	4.33
Two or more races	54	4.11
Native Hawaiian/Pacific Island	13	0.99
American Indian/Alaskan Native	9	0.68
Nonresident Alien	2	0.15
Student Age	**Count**	**Percent**
Age 19-24	139	10.57
Age 25-34	659	50.11
Age 35 and older	517	39.31

Figure 2.

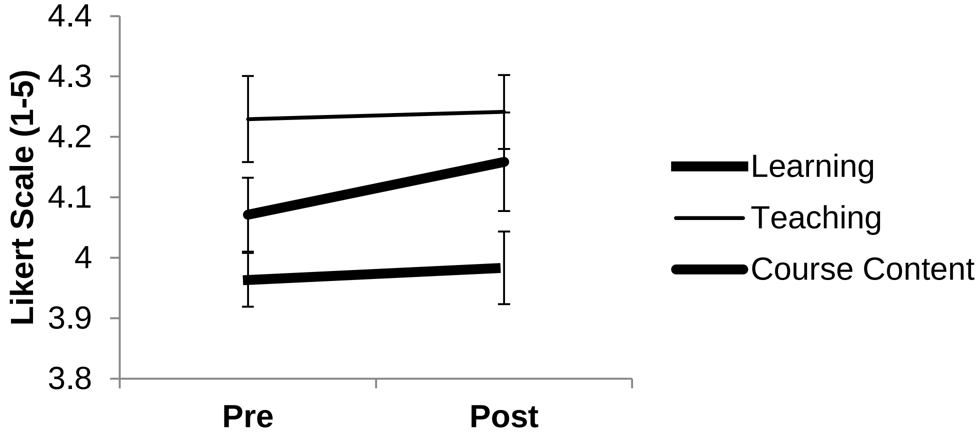

Figure 2. Comparisons of means of all survey responses pre and post course redesign. Error bars represent the standard error of the means.

Table 4. *Standardized Coefficients of ANCOVA and Significance Values for Ethnicity, Age, BIO100 Grade, and Pre- vs. Post-intervention on BIO100A Grade. Overall Test Values: $r^2 = 0.3314$, $p < 0.0001$*

Term	**Estimate**	**Standard Error**	**t Ratio**	**Prob>|t|**
Age	0.0137631	0.003262	4.22	<.0001
BIO100	0.7127021	0.033424	21.32	<.0001
Pre vs. Post	0.0483369	0.028096	1.72	0.0856
Asian	0.0203899	0.109672	0.19	0.8525
Black or African American	-0.271492	0.076952	-3.53	0.0004
Hispanic	-0.02998	0.059413	-0.50	0.6139
Two or more races	0.1570447	0.112125	1.40	0.1616

Table 5. *Standardized Coefficients of ANCOVA and Significance Values for Ethnicity, Age and Pre- vs. Post-intervention on BIO100 Grade. Overall Test Values:* $r^2 = 0.0700, p < 0.0001$

Term	**Estimate**	**Standard Error**	**t Ratio**	**Prob>|t|**
Age	-0.000868	0.002817	-0.31	0.7579
Pre vs. Post	-0.014553	0.024172	-0.6	0.5472
Asian	0.1277545	0.093763	1.36	0.1733
Black or African American	-0.432985	0.06502	-6.66	<. 0001
Hispanic	-0.077159	0.050874	-1.52	0.1296
Two or more races	0.1448555	0.095754	1.51	0.1306

Table 6. *Coefficients and Significance Values for a Multiple Regression of Course Design and Original Enrollment on Attrition. (Overall test* $r^2 = 0.1631, p = 0.0063$*)*

Term	**Estimate**	**Std Error**	**t Ratio**	**Prob>|t|**
Pre vs. Post	0.1482035	0.3901	0.38	0.7054
Original enrollment	0.2406429	0.072577	3.32	0.0016

Figure 3.

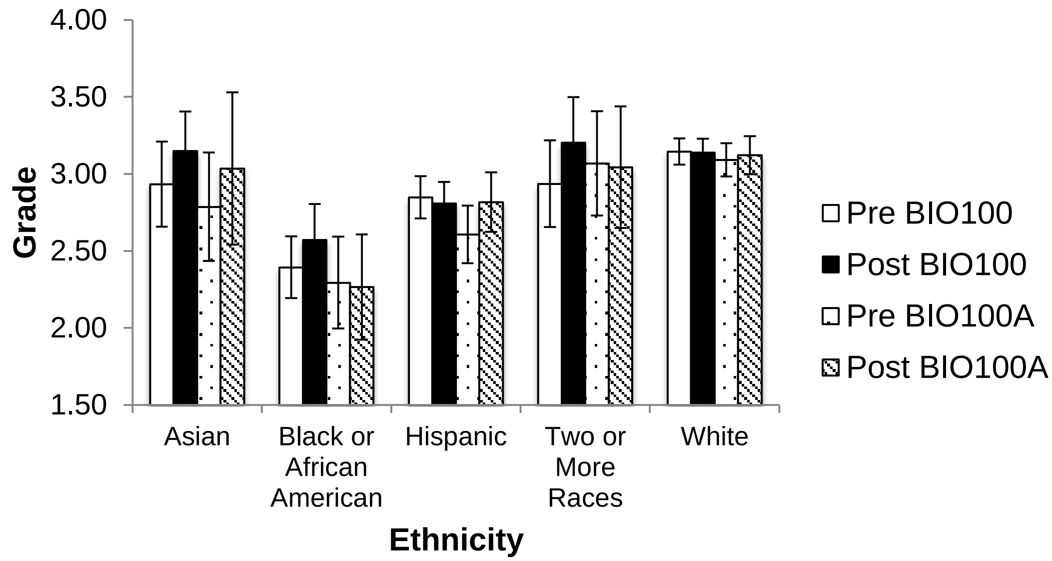

Figure 3. BIO100 and BIO100A grades, pre and post redesign, by student ethnicity. Error bars signify standard error of the means.

Figure 4.

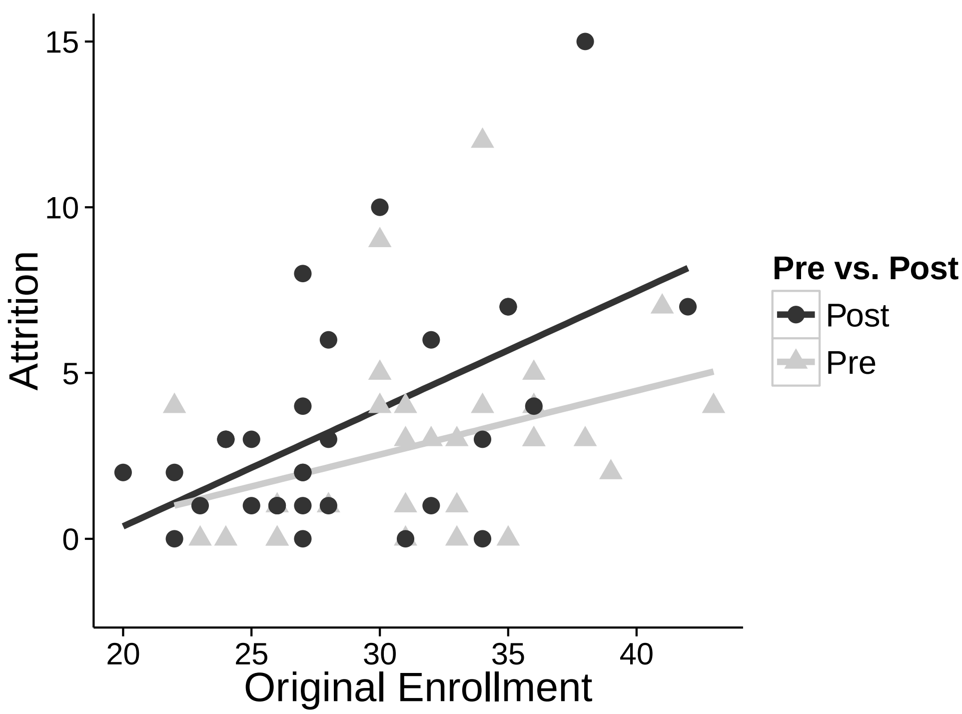

Figure 4. Relationship between original enrollment, course design, and attrition in the BIO100 classes.

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Mobilizing the Newsroom in an Online Class: How Master's Journalism Students Capture, Edit, and Publish the News

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Abstract
Mobile technologies are changing the way university students interact with online course content. In a pilot program at one institution, digital journalism students worked with an iPad Mini 3 (iPM3) to capture, edit, and publish the news. Nine students in this qualitative research study reported an ease of use greater than in previous field experiences of news reporting. The data showed this was due to three main attributes: mobility, the portability and compact nature the device; speed at which the device was adopted, (adoption of innovation); and immediacy, the ability for the student to quickly perform news functions.

Keywords
Digital journalism, mobile technology, reporting, higher education

Introduction

The field of Journalism has changed rapidly. Social media has greatly influenced journalism practices; thus, journalism as a field continues to be impacted by affordable mobile technologies, and by almost ubiquitous wireless access. No longer are camera crews hauling teams of people and heavy equipment to capture a story and create a news report. Rather, individuals with mobile and wireless technologies are developing the news simply, affordably, and easily. Multiple models of journalism include "shared newsrooms for print, broadcast, and online with a single assignment news desk, separate online news operations, cross-promotion between print and broadcast outlets, team storytelling across platforms, and linked Web sites converging media for news" (Artwick, 2004, p. 227). In fact, the convergence of media in Journalism is more of a norm than an exception. Digital journalists have invested in digital media since the early 2000s, blending more traditional journalism with online journalism. As background research for a book about online journalism courses in the U.S., Foust (2004) scanned 16 Journalism programs in higher education, noting that students "need to learn to use multiple platforms to report and distribute the news" (p. 271).

What is Digital Journalism?

> Digital journalism is about concepts and history; it is about reporting and writing and research; it is about issues beyond software, and these issues have been at the heart of journalism, journalism education, and research for a century. (Henderson, 2005, p. 421)

Contemporary journalism students in higher education will be more inclined to access their course material online, take their entire course of study online, and, like their peers and most of the adult population in the United States, will also access personal news and other media streaming through a mobile device. According to the Pew Research Center on Journalism and the analysis of comScore data, "At the start of 2015, 39 of the top 50 digital news websites had more traffic to their sites and associated applications coming from mobile devices than from desktop computers" (Pew Research Center, 2015, p. 4).

Mobilizing the Newsroom

Briggs (2010, 2013, 2015), a noted author and journalism educator, discussed trends in journalism:

> The impact of the video age has been felt far and wide . . . high school students are receiving formal training, shooting and editing video at school. Those who go on to journalism school will graduate with a broader array of skills than most of the experienced journalists working today. (Briggs, YEAR, p. 209)

In fact, Bullard (2011) wrote, "the Internet challenges journalists and journalism schools to keep abreast of technologies deployed to deliver the news" (p. 1). One impact of the Internet discussed by Graham and Greenhill (2013) stated, "The Internet has transformed the entrenched product-driven linear sequence of activities between producer and consumer of news into an intertwining service network of capabilities and a set of relationships that supplies and receives essential resources" (p. 91). The Internet and its vast information helps to blend online and offline media.

Now with mobile devices in the journalism class, students can capture, edit, and publish the news efficiently, effectively, and qualitatively better than without using the mobile device. Why video reporting? Through the mobile device, all capturing capabilities are built in, editing is built in, and the ability to publish via the web is all contained in the unit. Video, above all other media, is the preferred medium by millennials and by most others. Analysts have predicted that by 2018, online video will be the most highly adopted service for residential and consumer use, "growing from 1.2 billion households to 1.5 billion households" (Cisco, 2015, p. 4).

Background of Study

Since 2012, the institution of study, a private non-profit university, has offered a fully online Master of Arts (MA) degree in Digital Journalism. The program consists of 14 contemporary courses, including The New News, Advanced Non-Fiction Writing, Backpack Audio and Video, International Reporting, Emerging News Business Models, and Online Publishing, to name but a few. During the 2014–2015 academic year, a pilot was launched that equipped each student with an Apple iPM3. The goal of the pilot was to increase students' ability to use a mobile and digital device for capturing stories, but most important, to prepare graduates to be more prepared to enter into (or advance in) the applied practice of digital journalism by becoming familiar with a technology that is becoming commonplace in the industry. To help achieve that goal, field-reporting skills were applied throughout the program for career readiness and for advancement in the field. Students were expected to take their iPM3s with them into the field in order to capture, edit, and publish rich media content from a single device.

Methods

The course, Emerging News Business Models (JRN 640), was the focus of the study. Data were collected pre, mid-course, and post course. Along with student data through interviews and by analyzing student projects, the researchers applied a case study methodology. Data collection for case studies usually focuses on three sources of data: observations, interviews, and documents

(Merriam, 1998). This primary research was conducted by the lead of the program with contributions by the course instructor. Student work, interview data from students, reflections, analysis of student news projects, and instructor interviews and reflections were collected for the study. The qualitative data were then analyzed by the co-authors of this paper using a constant comparative approach to analysis. As a result of the analysis of the interview data, three categories of efficacy emerged focusing on the benefits to using the iPM3 in the Emerging News Business Models course: mobility (portability and accessibility), adoption of innovation (ease of use and time from adoption to implementation), and Immediacy (ability to quickly script, record, produce, and distribute the news).

Research Questions

1. How does the student adapt and adopt the mobile technology device in the field journalism setting?
2. Does the use of the iPM3 increase efficiency in creating digital journalism projects?
3. Based on interview data, do students report satisfaction in using the iPM3 in field reporting?
4. Over time, does the quality of the student work increase?

Overview and Course Description

The university's Master of Arts in Digital Journalism program provided each MA student with an iPM3 device and a toolkit including a 3-in-1 lens, a tripod, and a backpack (see Table 1 for complete equipment descriptions). The idea was to equip the students in gathering news stories and in taking short high-definition video quickly and easily. There were nine students who took part in the class and subsequently in the study. A business reporter who was then working for a large urban newspaper taught the class. Near the time the study was complete, the instructor, a professional journalist, took a job with ABC Channel 10 News as a multimedia journalist. The instructor's class was identified to study how the students used iPM3s to improve reporting their stories. As a final project, students developed video reports 2 to 3 minutes in length. The videos were posted to the students' vlogs or to the student newspaper (thenuherald.com). The theme and subject of the class JRN 640 was about the changing nature of journalism and whether and how newspapers could survive online. The instructor, someone with experience in news reporting, commented,

> The class was called *Emerging News Business Models* so it was more theoretical about how the media is becoming digital today as opposed to journalism instruction. The class discussed the way media outlets are combining the Internet with their traditional platform with relevant examples. (Instructor Comment, March 2015)

The course was focused on a final journalism assignment as well as on business plans and on student outlooks on the future. Students were instructed to write a print news story and then capture (shoot), and edit the video using an iPad program called *Videolicious* (2015), an application that is used by many media organizations. The assignment requirements were for the student to combine print and video components into a multimedia package, which in theory could be a standalone story on a media outlet's website. By the end of the course, students each produced a video report that showed a range of skill at shooting air-quality video, even at times in recognizing newsworthy material.

Table 1. *iPM3 Equipment and Software*

iPM3 Component	Features
iPM3 Hardware	Camera capable of shooting full HD (1080P) quality video and capturing 5 MP (megapixel) quality still images
	Wide-angle camera lens
	Tablet arm to connect the iPad to a table or other stationary device
	Two microphones for recording audio
	64 GB (Gigabyte) hard drive capable of capturing approximately 5 hours of full HD video footage*
	Wi-Fi (data plans are also available through the user's cell phone provider)
	Padded backpack
iPM3 Software Included with System	iOS 8.1 operating system preinstalled
	Camera application, photos, messages, Face Time, mail, music, Safari, maps, Siri, calendar, iTunes Store, App Store, Notes, Contacts, iBooks, Game Center, reminders, clock, videos
	Videolicious was later added as an easy-to-use application downloaded from the Apple iTunes Store

*The available hard drive space for the video footage does not include pre-existing software or other files on the device.

Rationale for Piloting the iPad Mini 3

As a mobile device, the iPM3 is not unique; however, the Apple iPad is the most common tablet used in the field of journalism. According to an interview with the lead faculty of the Journalism program, the iPM3 was selected for a variety of reasons; "It is a one-stop-shop that allows a journalist to record and edit HD level video, including adding voiceover narration and titles." The lead faculty went on to state, "The native video editing software program iMovie is considered very intuitive [and] easy to use and provides enough features to create professional looking news content."

Because of the iPM3's Wi-Fi capabilities, the user, in this case the journalism student, can publish the content to the web or deliver it remotely to another user via file-sharing applications in order to increase the level of coverage and signal strength; a data plan can be purchased through the user's cell phone provider. Immediate access to the Internet is critical in reporting news, due to the nature of time-sensitive material. As a result, this device provides great portability, flexibility, wireless Internet connectivity, still-camera and video capabilities, and video editing, all at a fraction of the cost of a traditional camera setup.

The Final Assignment Prompt

The final assignment prompt from the instructor read as follows:

> For your final project, I want you to demonstrate the emerging news business model in your own line of work. Attend a local event for a news story (Some good ideas: a sporting event, a street fair, a music festival, a City Council meeting). Write a 500- to 600-word print article and do a 30-second video component to complement the story. DO NOT repeat the print story in your video; rather, find something extra at the event that will complement the print piece. Think of this as a complete package, so that you give the reader/viewer an additional reason to watch your video.
>
> The easiest way to do this is with an iPhone, or iPad using a program called Videolicious. The program is free on the App Store. What you need to do is use the iPad camera to record still images and videos. Then you open Videolicious and choose those images/ videos to use in a video. You can then record your voice over the video, while using your finger to move from image to image. The program will do the editing for you. Save the video, which will automatically go into your photo library. You can then e-mail it to me as an attachment.
>
> Here is an example of a successful assignment:
>
>> You're out doing a business story on the 60th anniversary of WD-40. You are interviewing the CEO of the company and he gives you a tour. You are walking with the CEO of the company, who shows you a room at the corporate office that he calls "the mortuary," explaining that it's a shrine of every failed knock-off of WD-40. You take out your device and get some video of "the mortuary." That's not going to be able to fit into your main feature story, which is on the business of the company. But it would make for a great video aside. Write your feature on WD-40 and then produce a 30-second video on the mortuary, which would be embedded in your business story.

iPad Efficacy: Instructor's Conclusions

Student success with the iPM3 varied based on their experience level and on the time in the Journalism program, which has rolling admissions; students can enter the program out of sequence. This can be a challenge, as new students may enter with less background and experience. "Students with more experience had fewer questions and hit the ground running. Those without had more issues, such as doing their stories and video in first person, or not having the best news judgment" (Instructor Comments, March 2015).

The Mobile Device is Vital in the Journalism Field

Mobile devices are vital, whether iPads, iPhones, or other devices in today's Internet-based media world. This is because of social media and the need to turn stories quickly. Students could have used the Apple iPhone since Videolicious (the app for video editing) is available on that device, which is easier to carry around in the field. If a person works in television, they are often filming their own stories, so the iPhone is better because it is less to carry. (Instructor Interview, August 2015). According to the Poynter Media Wire (Beaujon, 2013), Videolicious has been used by field journalists from the *Washington Post* as a medium for capturing the news.

The instructor, in field experiences, found the iPhone to be as useful as the iPM3, overall, but saw digital devices as vital for all field journalists:

> You can't always go back to the office or studio and produce the piece. Sometimes you have to get something up, and that's where they [digital devices] come in. However, the adoption of the iPM3 is a matter of preference among journalists, and each uses what works best for him or her. Sometimes you have to get something up, and that's where they come in. (Instructor Interview, August 2015)

It is important to note in digital journalism that flexibility and speed are of primary importance; in fact, students reported that the app Videolicious lacked a long learning curve and was rated as the most useful application, even more useful than iMovie.

Student Interviews: Post Production

The students completed the course in March 2015. By the end of March, nine students from the MA Digital Journalism (MA JRN) program were interviewed about their experiences using the iPM3 for a story in a subsequent course. The interview questions were intended to gather information about their experience with the iPM3 compared to the equipment they had previously used to gather, edit, and publish news stories. The questions focused on quality, portability, and value. The subjects were also asked to share their experience in regards to reactions they received from peers and from their interview subjects they encountered while working on the JRN story.

Interview Protocol

Following were the questions posed to each student in this study:

- Q1. Why did you decide to enroll in the Masters of Arts in Journalism (MA JRN)?
- Q2. What has the addition of the Mini brought to the program?
- Q3. In your opinion, is this a professional device or just for the consumer (about the quality)?
- Q4. What are the advantages of the iPad compared to a traditional set up?
- Q5. How have people (other journalists and subjects) reacted to your using the iPad Mini?

Qualitative Analysis of Student Interviews

As shown in Table 2, three themes emerged from the student interviews: mobility, adoption of innovation, and immediacy.

Table 2. *Analysis of Student Interviews*

Student responses	Theme 1: Mobility	Theme 2: Adoption of innovation	Theme 3: Immediacy
Q1. Why did you decide to enroll in the Masters of Arts in Journalism (MA JRN)?			
Learn how to shoot news stories hands-on		x	
Edit video		x	
Present online			x
Use excellent tools like the iPad Mini	x		
The program is unique. I don't think there's any program like this with hands on training.			x
I took this program in particular because I want to be a one-man-band. I want to be someone who can shoot, edit, and report on his or her own.			x
People need to be able to get the story out fast. We live in that "now culture," so journalists need to use that type of equipment like an iPad or iPhone.			x
Q2. What has the addition of the Mini brought to the program?			
Made a big impact, huge difference.		x	
Nowadays journalists need to know how to do it all; a necessity to do this job.		x	x
Need to know how to shoot, edit quickly, and submit it.		x	x
When there is breaking news you need to have a tool to be able to cover news, breaking news, & features.			x
I'm not hauling all the usual equipment I used to have to haul around.	x		
I'm used to having an iPhone.	x		

Student responses	Theme 1: Mobility	Theme 2: Adoption of innovation	Theme 3: Immediacy
Apple products are very user friendly; really easy to connect your stories with other Apple hardware and products. It's handy, lightweight.	x		
Q3. In your opinion, is this a professional device or just for the consumer (about the quality)?			
This device is for professionals. Videos look professional.		x	
I'd use it every day in the field.		x	
iPad Mini has better quality than some of the cameras other journalists are using.		x	
You can do everything within the iPad, shooting video and editing.		x	
Q4. What are the advantages of the iPad compared to a traditional set up?			
This is the latest and greatest.		x	
iPad makes everything a little bit easier.		x	
Very intuitive.		x	
Picture quality is just outstanding.			x
Q5. How have people (other journalists and subjects) reacted to your using the iPad Mini?			
I let people know I'm going to be filming with this iPad. I know it's new. It might not seem that professional, but everyone uses this equipment.		x	
Resolution, HD quality of the shot, a more clear picture than what I had before.		x	x
Able to edit with the software within the iPad.		x	x
Makes for a better story.			x
Haul around huge tripods and huge cameras everywhere; not as much equipment.	x		x
I can edit wherever I'm at.	x		x

Results

Evaluation Criteria

Quality. Overall, the students reported the quality of the video footage was exceptional. Students were able to shoot video in full high definition (HD). The image quality produced by the iPM3 is superior to that of some cameras still in use today that are only 1–3 years old and are much more expensive. One student, a professional journalist in the master's program, commented it was possible to "capture broadcast quality video footage that is equal to or better than a $30,000 camera" (Student 1, interview, March 2015). The high quality of the equipment and of the video broadcast was a consensus by all students in the class. Another student commented, "People don't realize that the iPM3 has better quality than some of the cameras other journalists are using. (Student 3, interview, March 2015).

As noted by Journalism author, Mark Briggs:

> The advent of cheap digital video cameras and free video editing software has ushered in the video age. Instead of a $35,000 camera, an even more expensive editing station, a two-person crew and years of training, one person can produce high-quality Web video with a $200 camera and a laptop or desktop computer. (Briggs, 2010, p. 209)

Mobility. The subjects were also asked to comment on the all-in-one capabilities, which added to the overall mobility and portability of the device. "I tell other journalists I can do everything on the iPad and it works just as good as everything you're hauling around . . . or maybe even better" (Student 1, interview, March 2015). In a traditional setup, the footage shot in the field would need to be brought back to the studio in order to be edited and sent out for broadcast; the exception, of course, is when there is a news van with all the necessary equipment.

The iPM3 provides an opportunity for journalists to do it all in the field. One student commented being "able to edit with the software within the iPad" (Student 3, interview March 2015). The Wi-Fi capabilities (and potential data plan that provides greater range of web connectivity) allow users to collect, edit, and publish to the web directly, to an online news source, or to be sent back to a studio (using one of a variety of cloud-based file-sharing applications)—that is, the ability to complete all phases of a journalist's role out in the field.

One student alumnus, a former police officer, a Public Information Officer (PIO) and TV journalist, stated: "A microphone is $9 at Guitar Center. Everything I needed for the program I had by just using the iPad and external microphone and being aware of ambient sound" (Student 3, interview, March 2015). Another student said, "Everybody now has an iPad or an iPhone" (Student 4, interview, November 20, 2014). Other students highlighted the program's positive points and attributes of the iPM3.

Immediacy. In the fast-paced media and news world, replete with the up-to-the-second breaking news, it is critical to be efficient with time and with the story. The ability to deliver news quickly via smartphones, netbooks, and other devices is driving the work of the field journalist. Boyer (2010), an anthropologist, examined German news organizations and described this immediacy as phenomenal, specifically "the social phenomenology of fast-time practice" and the "harmonized attentions of the contemporary news industry" (p. 83). Boyer emphasized, "phenomenology argues that knowledge emerges and is refined through intentional practices," and he underscored that phenomenology is a useful analytical perspective to describe newsrooms today. Lazaroiu (2010) found the "architecture of new media and the degree of connectivity made possible by the new media infrastructures have caused the need for the mediation of immediate news reporting" (p. 195).

The one-course-per-month format for the courses at the subject institution makes time an element that only adds to the necessity for expediency and efficiency in gathering the news and in finalizing the end product. The application Videolicious, available for the Apple iPad Operating System (iOS), enabled students to complete their video pieces in a few short weeks. Even the *Washington Post* (Beaujon, 2013) deputized some of its reporters to create videos using the portable video-editing app.

"In journalism today it's just up and go, so having the iPad Mini, it's helped me a lot in terms of time." One student explained using the iMovie application because "you can always connect to a public WiFi or hotspot to upload all [my] story projects to You Tube or another video sharing site." (Student 1, interview, March 17, 2015).

"Ever since I got the iPad it's made a huge difference," said a student broadcaster for *America One News*. "I plan to do a story on Farmer's Markets. The main difference for using the iPad over another device is the overall high quality of the video package." Due to the JRN program, there was an opportunity to advance the student's digital skills through hands-on training (Student 2, interview, March 17, 2015). The simple notes function on the device helped this student to write scripts for stand-ups on camera.

Diffusion of Innovation and Adoption of Mobile Technologies in Journalism

The application of mobile devices in university journalism classes may be measured by stages of adoption. In this case, students adapted and adopted the mobile devices with ease and expediency. Rogers' (2003) Diffusion of Innovation Theory used five stages of classification and included innovators, early adopters, early majority, late majority, and laggards. In each adopter category, individuals were rated in terms of their innovativeness: "Innovativeness is the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a system" (Rogers, 2003, p. 22). For Rogers, innovativeness helped in understanding the desired and main behavior for the adopters, which was based on innovativeness. It is quite possible that journalism students in this study may have passed through the early stages of innovativeness at a rapid pace. Reasons for this are taking into consideration the other usability factors of the device itself, including mobility and immediacy.

Garyantes and Berkey-Gerard, in a 2015 study with journalism students using mobile devices, confirmed the application of the diffusion of innovation: "Factors that influence an individual's decision to adopt a new technology or device have been a focus in user acceptance, social cognition, social psychology, and innovation diffusion scholarship for the past several decades" (p. 34). In their study, they concluded those who used the devices for their assignments "found them easy and familiar to use, accessible, and fast" (Garyantes & Berkey-Gerard, 2015, p. 40).

Assessment of Student Work

Instructor feedback is critical to the success of the class and to the overall success of the program. Assessment in performance-based courses like Digital Journalism, where students are creating videos, may need to include both formal and informal assessment as well as feedback from peers. One of the Classroom Assessment Techniques (CATs) includes reflection as a means to assessment, going beyond testing the acquisition of knowledge, procedural learning, and conditional learning.

Cuillier and Schwalbe (2010), in their content analysis of 253 award recipients of journalism and mass communication courses, suggested that in addition to assessing student work with more traditional methods, students should work together in groups to apply inquiry-based discovery and investigation. The instructor the JRN course worked primarily as a coach, guiding students through their own learning. Instructor feedback was given to the students in a text format and included suggestions for improvement. Unlike many of the courses reviewed by Cuillier and Schwalbe, no rubric or CATs were implemented in the pilot course, although students did some reflection in the Threaded Discussion board on their course site.

Feedback to Student1 by the Instructor:

> I really appreciate all of the effort you put into this. Honestly, I can say I think this was the best exercise possible for someone learning how to do journalism. Here are a few things to work on. First, for print, you did a good job of getting me the who, what, where, when, why, etc., but you need to add some direct quotes, some context from outside sources, and not write in the first person . . . . That <content> grabs the reader at the outset, and you can let the writing flow after that. For the video, you want to start with your best video, and cut the city council shots entirely. We saw the back of his head for 20 seconds and then finally saw the park. Start with the park and in your narrative say what the video is showing, and then fill in with background on the council. Your vocal delivery is excellent, you sound like a pro broadcaster. Good luck and stay in touch.

Feedback to Student 2 by the Instructor:

> Here are a few things to work on. First, for print, you did a good job of getting me the who, what, where, when, why, etc., but you need to add some direct quotes, some context from outside sources, and not write in the first person. Also, your tone reads a lot like a newsletter as opposed to journalism—in other words, you need to write like you're talking to your best friend, so instead of summarizing at the outset, say something like "Homelessness remains an issue in Upland despite efforts from local business leaders and volunteers, the head of the homeless task force told the Upland City Council Monday . . . ." And then go from there. That grabs the reader at the outset, and you can let the writing flow after that. For the video, you want to start with your best video, and cut the city council shots entirely. We saw the back of his head for 20 seconds and then finally saw the park. Start with the park and in your narrative say what the video is showing, and then fill in with background on the council. Your vocal delivery is excellent, you sound like a pro broadcaster.

Feedback to Student 3 by the Instructor:

> I like how you took us to the Pentagon, and gave us some insight, but this reads more like an advertisement than a newspaper article. Writing in the first person isn't something journalists do in articles. Plus, if you're going to do a story on a program or a tour, you should write about the tour itself, what its lessons are, some of the history, interview attendees, key organizers, and then write a feature story such as something that can start like (I'm making some of this up): "More than 30 students got their first look at the Pentagon on Sunday, as they took a tour of the government's

biggest defense offices. The group, from Smith Elementary School, met with a Lt. Col., saw the inner mall, and got a lesson in political engagement. The Pentagon has been giving these tours for ‘x’ number of years, despite federal budget cuts.”

Assessment scores for the final project displayed a slightly lower median score (82%) than what was anticipated, as shown in Table 3. Overall, despite students’ reporting positive functions of the iPM3, scores ranged from a high of a 95.5% to a low of 73.3%. This 12-point range may be due to a new instructor’s teaching the course. Standards, such as a grading rubric for assessing student work, need to be in place when the course is taught in the future.

Table 3. *Assessment Data of Final Print Project,* N = *9*

Student Number	Raw Score	Percentage	Letter Grade
Student 1	38/45	84.4	B
Student 2	33/45	73.3	C–
Student 3	41/45	91.1	A–
Student 4	41/45	91.1	A–
Student 5	43/45	95.5	A
Student 6	35/45	77.5	C+
Student 7	43/45	95.5	A
Student 8	35/45	77.5	C+
Student 9	43/45	95.5	A
Average	39/45	78.0	C+
Median	41	82.0	B–

Limitations

There are many advantages to using the iPM3 to perform the tasks that journalists perform. However, the ease of use, portability, and inexpensive features can come with some limitations. The image quality when shooting in ideal conditions (outdoors on a sunny day) is equal to that of many cameras that are far more expensive, but it does not have equal quality when shooting in less-than-ideal situations (indoors, dusk or night time, etc.). The built-in audio is also not professional grade. External hardware is available that can help mitigate these issues; a mounted light, wireless microphone, etc., can narrow the technological gap that might be present in some situations.

Limitations of the study are inherent to data collection in a pilot program and to collecting the data from such a limited sample size. In addition, there is a need to expand the number of subjects for the study. Future research may need to include a scale of usability based on the three criteria derived from this study.

Conclusion/Implications for Future Research

Results

It is clear that the benefits of the iPM3 are numerous. Results of the study demonstrate many attributes of the success. While iPads do not replace the need for instruction in many other areas of journalism, the mobile devices have proven to be an exceptional tool and have become a necessary device for the field of journalism. While the analysis of the text stories mostly showed basic journalism competence, some students were less able to produce footage with proper lighting, focus and audio. This may be due in part because they had not yet taken JRN 610, Backpack Audio & Video. In a couple of cases, students were essentially "flying without a net" because they planned to take JRN 600, The New News, at the end of their programs rather than at the start. Had they taken the program in order, this issue may not have occurred.

The best student stories were those that came from students who had a broadcast TV background, as they showed more comfort and familiarity with video production skills. Along the way, some students experienced difficulties, but primarily it was those who had not yet studied either JRN 600 or JRN 610. Therefore, the open entry requirement to take courses out of sequence has had an impact on scheduling the string of courses in the program.

The Apple iPM3 sets the standard that all devices need to reach. However, there were challenging issues, such as recording good audio, that proved vexing for students. There was a need for students to have stronger WiFi connectivity with their iPM3s that iPhone users state they experience. Faster WiFi could possibly increase the journalist's confidence in reporting.

The Future of Digital Journalism

Will all news be delivered only in video or by broadcast media? What social changes will occur that will impact media in the future, potentially changing the curriculum of Digital Journalism? Today, 85% of the 7.1 billion world population have access to the Internet. About 25% of the world's population use social media, and three-quarters of the entire online population use social media sites like Facebook, Twitter, You Tube, or Google (Conde, 2014). In the chapter on Crowd-Powered Collaboration within *Journalism Next: A Practical Guide to Digital Reporting and Publishing* (3rd edition), Briggs (2015) made a bold statement about social media: "Any journalist who is adept at using social media has a distinct advantage in terms of source development over journalists who do not think it's for them" (p. 133). Abramson (2010) commented, "Decades from now, the quality newspapers that remain may not be literally on paper" (p. 43) Social networks and social media may become a community of news-making friends.

Another trend that is not going away is collaborative publishing and crowd sourcing, although crowd sourcing, according to Briggs (2015), "remains an experiment, . . . news organizations are constantly looking for ways to leverage the power of the crowd to help them improve their reporting and publishing" (p. 132). Gilligan (2011), in an essay on the impact of online publications' expanding to reach more of a level of community journalism, maintained these more social forms of online news would encourage a discourse that is not bound by geography, rather than by a pluralistic society of like-minded, news-seeking individuals.

In Boyer's (2010) article entitled "Digital Expertise in Online Journalism (and Anthropology)," more was discussed about digital media's taking over traditional journalism. However, Boyer did not necessarily consider this a bad thing. He described digital media as a "blogosphere now devoted to online journalism, citizen journalism, news blogging, the future of journalism, and so on" (p. 80).

As a matter of fact, not only is journalism becoming more collaborative, but it is also changing the narrative of storytelling. Rather than a complete story, many articles are reduced to bullet points with short pithy, Twitter-like prose. Stephens (2014) summed it up by his comments in his chapter, Sculpting More Shapely Forms," within the book, *Journalism Unbound: New Approaches to Writing and Reporting:*

> The rapidly morphing digital universe is already showing signs that it will prove less friendly to scene and narrative-based story organization than print, film, and television have been . . . . We tend to surf—at least so far—skittishly, impatiently. In fact, we tend to do a lot nowadays skittishly, impatiently. Scenes take time and space to establish. Narratives take time and space to tell. And they would seem to require some concentration and stick-to-it-iveness to read. Perhaps we are losing that. But to look at this less pessimistically, there are also signs that we are using these digital tools to come up with alternative organizational strategies for stories: strategies that might be more effective than scenes or narratives. Web sites and much of the rest of what appears on the screens of laptops, tablets and smartphones tend to break out information into lists, charts, graphics or even moving lists, charts and graphics. Might such more visual and intuitive organizational strategies eventually begin to overcome our early 21st century entrancement with the scene or the narrative? (Stephens, 2014, pp. 160-161)

And so, "convergence will continue to drive the interconnectedness of media in journalism, particularly in the field of digital journalism. The value and importance of the culture of web journalism, and the power relationships embedded in the mass-communication system suggests that the convergence between television and digital media will continue to make those interconnections between all media" (Plaesu, Drumea, Paun, Pârlea-Buzatu, & Lazaroiu, 2011, p. 314).

In conclusion, the success of the degree programs at the university level depends largely on students' ability to stay current and relevant. The Apple iPM3 and other mobile technologies will give students access and equity to developing a more social news style that is being embraced by ordinary people. The pilot study shows mobility, adoption of innovation, and immediacy to be factors that contribute to the success of the accomplishing the goal of field reporting in the 21st century.

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Appendix A
Student Video

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Note to the Author

Journal of Research in Innovative Teaching

An Annual Peer-Reviewed Publication of National University

The journal's mission is to collect and disseminate advanced research-based information on teaching and learning, particularly focusing on innovative methodologies and technologies applied primarily but not exclusively in higher education, to enhance student learning outcomes.

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Every submitted paper will be acknowledged and refereed.

A manuscript is to be submitted in electronic form to the Editor-in-Chief or to any of the members of the Editorial Board in a camera-ready form (e.g., single spaced and with tables and figures properly placed within the manuscript.) Manuscripts are accepted for review with the understanding that the same work has not been published, that it is not under consideration for publication elsewhere, and that its submission for publication has been approved by all authors and by the institution where the work was carried out; further, that any person cited as a source of personal communications has approved such citation. Written authorization may be required at the editor's discretion. Articles and any other material published in JRIT represent the opinions of the author(s) and should not be construed to reflect the opinions of the editor(s) and the publisher.

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NO FORMATTING STYLES ARE TO BE APPLIED

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Manuscripts must be submitted with the following information shown for each author: full name, degree(s), position in the author's department, school, name of institution, full address, telephone and fax numbers, and email address.

The manuscript, including the abstract, references, tables, figures, and figure captions, should be prepared to fit on letter-size paper, single-spaced, with one-inch (1") margins on top, bottom, left, and right. The first page should contain the article title, author and co-author names, abstract, and key words.

Abstracts must not exceed 100 words.

Key words (6–8) should be listed immediately after the abstract, in lowercase type.

Notations (if required) should be legible and compact and conform to current practice. Each symbol must be clear and properly aligned so that superscripts and subscripts are easily distinguishable. Numerical fractions should preferably be put on one line—e.g., ½ or 1/2.

Equation numbers should be placed in parentheses at the right margin. References to equations should use the form "Eq. (3)" or simply "(3)."

In-text citations should follow APA style. Example: (Smith & Jones, 2008; Thomas, Adams, & Schumann, 2006). Be careful to spell authors' last names accurately and show the same publication year as listed in the references.

Footnotes, if necessary, should be indicated in the text with superscript numbers (1, 2, 3, etc.), using Microsoft Word's Footnoting feature.

References should be listed in Microsoft Word's hanging-indent (first-line indent) style; whereby the Enter key is struck only at the end of each reference listing, and the Tab key is never used to force an indent. List all references in alphabetical order by author's last name. The format for each reference should correspond to APA style. Here are examples of a book entry, Web-based text, and a journal article, respectively:

Miller, R. I. (1972). *Evaluating faculty performance*. San Francisco: Jossey-Bass.

Nation, P. (2003). The role of the first language in FL learning. *Asian EFL Journal*, *33*(2), 63–66. Retrieved from www.asian-efijournal.com/june_2003_pn.pdf

Stapleton, R. J., & Murkison, G. (2001). Optimizing the fairness of student evaluations: A study of correlations between instructor excellence, study production, learning production, and expected grades. *Journal of Management Education*, *25*(3), 269–291.

References should be listed at the end of the text material. When including URLs, please remove the hotlinks (hypertext links); there should be no hotlinks in the article or in the References.

Figures should be numbered with Arabic numerals in the order of mention in the text and should be inserted at the nearest convenient location following that mention. The Figure number and caption should be horizontally centered on separate lines below the figure, and the caption should use sentence-style capitalization and punctuation for titles (for example: "*Figure 1*. Comparison of online and onsite enrollments."). Figures must be horizontally centered between the margins.

Tables should be numbered with Arabic numerals in the order of mention in the text and should be inserted at the nearest convenient location following that mention. Every table must have a title, which should be horizontally centered above the table, and the caption should use title-case capitalization (for example: "Table 1. *Results of Survey Respondents*"). Tables must be horizontally centered between the margins.

About the Author will appear at the end of your article. List each author in the same sequence as shown below your article title. For each author, provide full name, degree(s), title(s), department/school, college/institution, email address, and a brief list of major research interests.

Submission deadline. Submissions for the next, 8th issue will be accepted until October 1, 2014. Please email your manuscript to Dr. Peter Serdyukov at pserdyuk@nu.edu.

Formatting Guidelines

Title (14pt bold, followed by 12pt white space)

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Abstract (10pt bold)
Contents (10pt regular, maximum 100 words), full justified, followed by 12pts white space).

Key Words (10pt bold)
Contents (10pt regular, maximum 6 to 8 key words), full justified, sentence case (but no period), followed by 24pts white space)

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First paragraph not indented; full justified; no white space between paragraphs.

Subsequent paragraphs indented 0.25"; last paragraph followed by 12pts white space if next subheading is Level 2, or 24pts if the next item is a table, figure, Level 1 subheading, or References.

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This is a Level 3 subheading, which is shown in sentence case. Note that there is no first-line indent, and the subheading is run-in with the first paragraph.

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Brown, H. (2007). *Principles of language teaching and learning.* White Plains, NY: Pearson Longman.

European University Association. (2010, May 26). A global crisis: New report looks at the effects of the economic recession on European universities. *Education Insider.* Retrieved from http://education-portal.com/articles/A_Global_Crisis_New_Report_Looks_at_the_Effects_of_the_Economic_Recession_on_European_Universities.html

Appendix A (12pt bold)
Title (12pt bold, followed by 12pts white space)

Text of appendix in 12pt, full justified, followed by 24pts white space before next appendix or About the Author(s).

About the Author (10pt bold, followed by 12pts white space; all type in this section is also 10pt)

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