EFFECTIVENESS OF ONLINE PROFESSIONAL DEVELOPMENT FOR TECHNICAL EDUCATORS

by

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To my father, Don R. Ratcliffe, Ph.D., for modeling lifelong learning and the joy of discovery. You will always be the smartest man I know.

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LIST OF ABBREVIATIONS

Canvas Instructure LMS – Learning Management System – Canvas Instructure is an open-source online course platform providing access to online course content.

CTE – Career and Technical Education - is the division of secondary education established through the Carl D. Perkins Vocational and Applied Technical Education Act of 1990 as programs that include "job and work skill attainment or enhancement" which is measured by progress and proficiency in "achieving occupational skills" (Castellano et al., 2007).

IDOE – Indiana Department of Education

IDWD – Indiana Department of Workforce Development

LOGM 127 (Introduction to Logistics) – Ivy Tech Community College introductory course on Logistics, which is also used as a high school dual-credit course.

MSSC CLA – Manufacturing Skills Standards Council Certified Logistics Associate – a nationally recognized certification on introductory logistics concepts and skills.

ABSTRACT

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Numerous studies have shown multiple benefits gained through professional development for teachers, which address increasing pedagogical content knowledge, increasing student achievement and increasing teacher job satisfaction (Banks, 2008; Colbert, Brown, Choi &Thomas, 2008; Dash, de Kramer, O'Dwyer, Masters & Russell, 2012). However, barriers to professional development, including cost, time and access, make face-to-face professional development sessions difficult to meet teacher needs (Carr, 2016). Online professional development can help to address these barriers, while meeting the needs of teachers. Employing best practices established through both online learning pedagogy and professional development techniques, teachers can increase their pedagogical content knowledge and opportunities for collaboration using online platforms. This study demonstrated, using a blend of qualitative and quantitative assessments that online professional development was comparable in effectiveness to face-to-face professional development in preparation for teaching an introductory logistics course and the Manufacturing Skills Standards Council Certified Logistics Associate certification exam.

CHAPTER 1. INTRODUCTION

1.1 Nature of the Problem

While professional development has long been viewed as an important part of teacher satisfaction and student achievement (Colbert, Brown, Choi & Thomas, 2008), barriers, including limited time, financial support and applicable content, can make professional development of educators difficult to maintain on an ongoing basis (Edney, 2010). With the increase of college-level course work being taught in high school classrooms (referred to as "dual-credit coursework"), teacher development is necessary to ensure that students receive the same rigor in dual-credit courses as experienced in the college classroom. For dual-credit courses involving technical competencies, such as engineering and technology disciplines, teachers must be prepared to provide career guidance, facilitate project-based learning, teach the latest industry trends and train with ever-advancing technology. Additionally, dual-credit coursework must align both to state high school curriculum standards and the college-defined learning objectives for each course. Such alignment includes using college-approved assessments and meeting the outcome measures as defined by the college institution offering the credit. These additional factors are critical to ensure that professional development addresses best practices in pedagogy, changes in learning technologies and changes to the subject matter they are teaching (O'Connor, 2012; Wichowski & Heberley, 2004).

Professional development can occur in a wide variety of formats including partial day or one-day workshops, multi-day workshops and conferences, multiple week intensive training courses or long-term mentor-based relationships (Bottoms, Egelson, Sass, Uhn & Board, 2013). Studies have established best practices for teacher professional development based on research focused on teacher perceptions of the professional development and student achievement in coursework

(Banks, 2008; Barlow, Frick, Barker & Phelps, 2014; Baxter, Ruuzicka, Beghetto & Livelybrooks, 2014). However, barriers to professional development, including limited funds for travel activities and limitations of time available for such activities, are common and make it difficult for teachers to maintain the level of professional development they desire (Barlow, et al., 2014).

With the onset of online learning platforms, teachers have additional opportunities for access to training and resources that eliminates the expense of travel. Online learning platforms also provide larger networks for communication and peer support than regional based opportunities (Carr, 2016; Dede, 2016). Online platforms also facilitate asynchronous activities, allowing participants to complete work in ways that best fit their schedule.

1.2   Statement of the Problem

While previous studies have investigated the teacher preferences in professional development content, delivery method, duration and format in face-to-face professional development endeavors, little quantitative research has been done to asses the effectiveness of teacher professional development using online modalities.

Studies related to online professional development have been qualitative in nature, often focusing on teacher preferences (Casale, 2011; Dede, 2016), perceived effectiveness (Castellano, Harrison & Schneider, 2007) and establishing best practices for online content through survey data and interviews (Kleiman & Wolf, 2016; Schoenbach, Greenleaf, Brown & Howlett, 2016). While best practices based on teacher perceptions and preferences have been documented for online professional development, there are no studies documenting the effectiveness of professional development for technical educators delivered online, compared to the same content being taught in a face-to-face format (Desimone, 2009). Without empirical data, it is difficult to

conclude if online professional development is as effective as face-to-face methods, and thereby a suitable solution for providing low-cost, convenient professional development for technology instructors. This study measured and documented teacher feedback from instructors provided professional development in a face-to-face format and those provided professional development through an online format, in addition to quantitative measures through assessment.

1.3   Purpose of the Study

The purpose of this study was to determine if online professional development is as effective as face-to-face professional development by examining the results of industry-defined curriculum standards, aligned to an entry-level course in supply chain management. Participants were instructors currently teaching a supply chain management course either for dual-credit in various Indiana high schools or as an entry-level college course at Ivy Tech Community College campuses. In addition to the quantitative measures reviewed using assessments established by the college curriculum, qualitative measures about teacher preferences and perceptions of the professional development content and delivery were evaluated.

1.4   Significance of the Study

The benefits of this research can be divided into three categories. First, this research provided a method of quantifying the effect of professional development based on the teacher's performance on subject-based assessments. Second, this research provided insight into teacher preferences and perceptions about professional development for technical coursework. Finally, this research can provide a basis for future research regarding online professional development for other courses.

1.5   Scope of Study

The scope of this study was limited to high school teachers offering dual-credit coursework

in supply chain management through Ivy Tech Community College or college instructors

teaching in the School of Business at Ivy Tech Community College. The instructors were from

various high schools and regional campuses of Ivy Tech Community College teaching or

scheduled to teach LOGM 127 (Introduction to Supply Chain Management and Logistics) in the

2017-2018 or 2018-2019 academic school years. Because this course is standardized throughout

the state of Indiana, results of this study are relevant to all Indiana high schools offering dual

credit in LOGM 127 and to all Ivy Tech campuses offering LOGM 127.

1.6   Rationale for Study

Previous research has established best practices for professional development, based on

teacher preferences or student achievement (Bangert, 2004). However, little quantitative research

has been conducted on the effectiveness of online professional development (Whitehouse, Breit,

McCloskey, Ketelhut, & Dede, 2002). Additionally, no quantitative research was found related

to the effectiveness of professional development specific to supply chain management

coursework.

1.7   Research Questions

This study answered three questions related to the effectiveness of online professional

development.

1. Is online professional development as effective as face-to-face professional development

   for training teachers in the content associated with LOGM 127 (Introduction to

   Logistics)?

2. Is online professional development as effective as face-to-face professional development for preparing teachers for the Manufacturing Skills Standards Council (MSSC) Certified Logistics Associate (CLA) certification?

3. How do teachers rate the effectiveness of each component of the professional development course?

1.8   Assumptions

The following assumptions were made for the study:

- All participants had access to Canvas Instructure Learning Management System.

- Participants were able to spend as much time as desired accessing the Learning Management System to review content.

- Participants completed the posttest and MSSC CLA exam once they felt they were suitably prepared for the assessments.

- The LOGM 127 end-of-course assessment (ECA) is representative of course content.

- Participants answered the Qualtrics survey questions honestly.

1.9   Limitations

The following limitations were acknowledged for this study:

- With voluntary participation, this study was subject to participant mortality during the execution of the study.

- As participants accessed the posttest (LOGM 127 ECA) and the MSSC CLA certification exam at a time of their choosing during the study, there were several individuals that did not complete the posttest.

- Participants were able to choose modality, making the sample size for the online course larger than the face-to-face group.

- Participants were able to complete the course at any time during the experiment time frame, making the duration of the course vary by participant.

1.10 Delimitations

The following delimitations were established conditions for this study.

- Participation was open to Indiana high school dual-credit business teachers and full-time or adjunct faculty in the School of Business from any statewide location of Ivy Tech Community College.

- All course materials were hosted on Canvas Instructure Learning Management System.

- All data for this study was obtained through the assessment instruments presented in the study.

1.11 Summary

Chapter One presented the research questions that were investigated by this dissertation, as well as an introduction to the need for this research, based on the problem statement and purpose statement and study significance. The scope of research and limitations were also identified.

CHAPTER 2.   REVIEW OF LITERATURE

This study provided qualitative and quantitative evidence to the effectiveness of online professional development, compared to face-to-face professional development, offered to technical educators. The sections below provide a review of relevant literature regarding previous research on this topic. Areas of particular interest included the need for professional development, special consideration for professional development impacting technical educators, best practices documented for professional development, rationales for providing online professional development, and previous research and assessment of the effectiveness of online professional development of educators. The literature review also includes details into previous research conducted with the assessment instruments chosen for this study.

2.1   Procedures for the Review of Literature

This review of literature made use of the Purdue Library system for both online and paper based resources. Online searches were conducted through HTTP://WWW.LIB.PURDUE.EDU. EBSCO Host facilitated the Boolean search of terms, using databases including Educational Resource Information Center (ERIC), Education Source and Education Full Text. The ProQuest database was used to search dissertations. Key search terms included: professional development; effectiveness; impact; assessment; online; career and technical education; teacher learning; instructional design. These terms were used in multiple combinations for gathering journal articles. All journal articles were peer-reviewed and had the full text supplied. Selected print sources were obtained from Purdue University's Humanities, Social Services and Education (HSEE) library on the West Lafayette campus.

2.2   Need for Professional Development

Professional development in education can be defined as "process and activities" that enhance knowledge, skill and attitudes of educators (Visser, Coenders, Terlouw, & Pieters, 2012). Professional development can include preparation for teaching new content, support during the instructional process and reflection for continuous improvement in future instructional settings (Visser, et al., 2012). While professional development has been deployed in various methods, ongoing research has shown a need to both increase professional development offered and to evaluate the most effective types of professional development available. Shulman and Shulman (2004) wrote that for professional development to be effective, teacher must be: "ready (possessing vision), willing (having motivation), able (both knowing and being able 'to-do'), reflective (learning from experience) and communal (acting as a member of a professional community)" (Shulman & Shulman, 2004, p. 259). Desimone (2009) provided a framework illustrating how effective professional development directly benefits student achievement. Desimone's research stated that when teachers experience effective professional development:

- The professional development increases teachers' knowledge and skills and/or changes their attitudes and beliefs.

- Teachers use their knowledge and skills, attitudes and beliefs to improve the content of their instruction or their approach to pedagogy, or both.

- The instructional changes foster increased student learning (Desimone, 2009, p. 184).

The *No Child Left Behind Act* of 2001 made it mandatory for K-12 teachers to participate in professional development activities each year to promote quality of education in the classroom (Estepp, Thorn, Roberts, & Dyer, 2014). Each state was given the liberty to determine how this professional development should be administered, however not all professional development

activities result in increasing the quality of instructional delivery in the classroom. While this act has been revisited by subsequent presidential administrations, the current public law requires 75% of funds available for programs of national significance to be dedicated to professional development activities for K-12 teachers (114th Congress, 2015)

Educating teachers requires a commitment to an ongoing need, not a short-term fix and needs to focus on true education of the teachers, rather than simple application of the latest technology or curriculum standard (Caverly, Peterson, & Mandeville, 1997). However, it is not enough to add new skills, but help develop new habits of practice out of "transformative learning" (Nelson, Slavit, Perkins, & Hathorn, 2008). Numerous studies have linked the effectiveness of teachers as being critical to student success (Banks, 2008; Colbert et al., 2008; Dash, Krammer, O'Dwyer, Masters & Russell, 2012). As teacher effectiveness is supported through professional development activities, any pursuit to increase student achievement must also include a strategy for ongoing professional development of instructors (Dash et al., 2012).

Because there are frequent changes in state standards, changes to how teacher performance is measured, changes in student outcome assessments and changes in available technology for classroom application, teachers require ongoing professional development, regardless of the number of years of experience they have in the classroom (Estep et al., 2014). Studies have also found that faculty were motivated to increase their development as a method to better teach their students (Caverly et al., 1997). Dash et al. (2012) stated that "professional development for teachers has been deemed the necessary approach to improving teacher quality" (p. 2). Instructional quality, leading to increased student success (Barlow et al., 2014) is only one of the benefits for professional development. Secondary teachers often experience a sense of isolation

while teaching, which can partially be addressed through professional development communities (Castellano et al., 2007; Cordingley, 2015; Nelson et al., 2008).

2.3   Professional Development for Technical Educators

Career and Technical Education (CTE) is the division of secondary education established through the Carl D. Perkins Vocational and Applied Technical Education Act of 1990 as programs that include "job and work skill attainment or enhancement," which is measured by progress and proficiency in "achieving occupational skills" (Castellano et al., 2007). While vocational or "shop" courses had long been taught in high school settings, the Perkins Act established federal funding for ongoing professional development for CTE teachers, as well as funding for other CTE program elements. This act also required states to submit annual reports documenting compliance to curriculum standards, proper use of funding and proper credentialing for CTE instructors.

Career and technical education instructors face all the same challenges as an academic subject teacher in secondary education. However, CTE instructors face additional challenges, unique to their programs, standards and content areas, which increase their need for professional development. As the nature of work, technology and job skills change, the career and technical education curriculum must continually adjust to meet these needs (Wonacott, 2001). Unlike the teachers of academic core subjects, career and technical education teachers must also align curriculum to industry certifications integrated into their course outcomes. These industry certifications change frequently and are typically managed by industry certification bodies, rather than educators or curriculum developers (Estepp et al., 2014).

CTE teachers are also expected to help find funding for their programs, which typically require new equipment and technology on an ongoing basis to support curriculum needs. To

accomplish this, teachers are expected to be familiar with federal funding sources, such as

Perkins grant, and other granting agencies to supplement school corporation funds (Cannon,

Kitchel, & Tenuto, 2013). In a survey documenting priorities for CTE instructors, national

directors of CTE programs reported the top 11 priorities as: dual-credit courses, integration of

academic and CTE classes, reading programs in CTE, development of career clusters, CTE

teacher technical skill updating, CTE teacher certification, use of distance learning technologies,

use of national skill standards, seamless curriculum development, developing entrepreneurship

programs and career awareness in students and parents (Wichowski & Heberley, 2004). Each of

these categories are expectations above and beyond those of academic core subject teachers,

making professional development for CTE teachers even more important. Leadership within

career and technical education is required to clearly communicate the vision for the program and

provide personalized attention to the needs of each teacher (Wonacott, 2001), including

supporting their ongoing professional development.

2.3.1   Rigor

CTE programs are more academically rigorous than in the past and require both technical

skills and compliance to academic standards (Castellano et al., 2007). Programming such as

Project Lead The Way (PLTW), which is a national pre-engineering and advanced science

curriculum for high school, and other science and engineering skills that are now included as

CTE programs have changed the type of CTE courses offered in the high school (O'Connor,

2012). By including PLTW or other advanced science and engineering curriculum as part of the

CTE curriculum portfolio, teachers may find themselves teaching a section of welding, advanced

manufacturing, pre-engineering and computer-aided drafting, all in the same semester. Each of

these courses not only have their own curriculum standards, but are often also aligned in

nationally recognized industry credentials, which are highly promoted in CTE curriculum (Castellano et al., 2007).

2.3.2   Student Demographics

CTE courses also have demographics that include a disproportionate number of students with below average skills and special needs (NRCCTE, 2011). This requires additional professional development support for new instructors, both who went through traditional credentialing programs and alternative credentialing programs. Multiple surveys of CTE teachers have pointed to the need for support in adapting curriculum to special needs students in CTE classrooms (Estepp et al., 2014). As seen in the literature reviewed, CTE teachers have to support multiple stakeholders, including administrator goals, special needs students, relevant industry partners and curriculum standards established by the state and by industry certifying bodies.

2.3.3   Credentialing

In addition to the areas of concern listed above, there continues to be an increase in CTE programs within the secondary education programs, however there is a marked decrease in the number of graduates in CTE teacher training programs (NRCCTE, 2011). Retirement of previous vocational arts teachers, as well as the reduction of CTE classes offered during the 1990's has created a limited pool of teachers available to teach CTE courses, which are now being offered at higher rates as workplace training programs continue to increase in high schools around the nation (Bottoms et al., 2013). Due to limitations of available credentialed CTE instructors, administrators often hire industry experts as alternatively licensed instructors and have to training them as educators (Szuminski, 2003). In his pilot study, Szuminski (2003) found that CTE instructors who received ongoing professional development had a better retention rate than new CTE instructors who did not receive ongoing professional development.

Some studies have shown no significant difference between alternatively and traditionally certified teachers (Szuminski, 2003). However, many alternatively certified CTE teachers expressed desire for higher levels of professional development and peer support in the early stages of their teaching careers (NRCCTE, 2011). Alternatively credentialed teachers account for up to 75% of teachers in CTE fields, making it the primary methodology for new CTE teachers to enter the workplace (NRCCTE, 2011). However, new CTE teachers look for support of other teachers, more preparation at the beginning of courses and mentors from experienced teachers. For these reasons, professional development is not only critical to current CTE teachers, but is expected to be an ever-increasing need of newly credentialed teachers in the future (Estepp et al., 2014).

2.3.4   Instructional Technology

In a study reviewing this transition, it was found that a dichotomy exists between the administrator beliefs about the impact of classroom technology and the actual practice by the CTE classroom teachers (Suarez, 2012). CTE administrators are expected to support CTE teachers in updating their curriculum to meet 21st century skills. Technology plans created by administrators do not necessarily include the necessary professional development to implement the new technologies effectively. While technology in the classroom increased, it was not actually utilized fully due to CTE teachers not understanding how to implement it well. Professional development needs included: understanding the importance of the technology; assistance in integrating the technology into the classroom; ongoing training via summer training, workshops and online courses; the need for a mentorship program for teachers and create a cohort of teachers to promote peer-led, activity-oriented, short-duration professional development. These activities help to differentiate between the presumed responses of the

teachers "not wanting to use the technology" instead of the actual lack of skills needed to use the technology (Suarez, 2012).

In a program which trained teachers how to better integrate classroom technology into their daily practice, it was found that as teachers were able to solve their own problems with online technologies, their confidence increased, and they collaborated with other instructors to develop new ways to use technologies to support student learning (Caverly, et al., 1997). The finding also supports the idea that teachers are willing to integrate new technology when provided the necessary support to do so, making this area a key focus for ongoing professional development.

2.4   Best Practices in Professional Development

Teachers are also learners when in the professional development context, making it appropriate to draw on learning theories when crafting development opportunities for teachers. Some learning theories helpful in professional development include cognitivist theory and acquisition models, communities of practice and participatory models, and constructivist theory with shared knowledge creation (Banks, 2008).

With the changes in technology, some researchers have observed successful professional development activities using a social constructivist approach (Banks, 2008). Educators learned better when they were working in teams and helping to teach one another (Caverly et al., 1997). In one survey, professional development models that included job-embedded elements and mentoring relationships were ranked as being the most effective, although most teachers responded that they did not receive as much professional development as they desired (Edney, 2010).

2.4.1   Pedagogical Content Knowledge

Teachers must have a working knowledge of school and curriculum standards, the pedagogical knowledge for effective teaching and the subject-matter knowledge of the courses

the teach. Each teacher then forms their personal construct that blends and balances these categories when instructing their students (Banks, 2008). Research has shown higher levels of student achievement when professors are prepared to teach from a pedagogy perspective, rather than just subject matter expertise (Louck-Horslsey, Hewson, Love & Stiles, 1998). A Master Teacher Initiative providing professional development for K-12 teachers from Colorado State University's College of Business was found to be significantly impactful both in the scholarship of teaching and the student outcomes (Gaal, 2014). These studies show that professional development must address multiple areas of instructional support. One area which has been highlighted as requiring ongoing support is pedagogical content knowledge. Pedagogical content knowledge can be defined as the teacher's ability to understand not only the subject matter content, but also the best methods to make the content understandable for student learning (Dash et al., 2012).

In a survey on types of professional development typically received, teachers noted that they do not receive instruction regarding the content they teach, although that is needed for higher levels of student instruction (Edney, 2010). As subject matters become increasingly complex, teachers continue to need training in the subject matter and technical content (Barlow et al., 2014; Baxter et al., 2014; Bottoms et al., 2013).

> Teachers' subject matter knowledge influences the way in which they teach, and teachers who know more about a subject will be more interesting and adventurous in their methods and, consequently, more effective. Teachers with only a limited knowledge of a subject may avoid teaching difficult or complex aspects of it and teach in a manner which avoids pupil participation and questioning and which fails to draw upon children's experience. (Banks, 2008, p. 225)

2.4.2   Collaboration in Professional Development

Teachers are in need of ongoing support formally and informally to support pedagogy, curriculum and teaching strategies (Desimone, 2009; Edney, 2010; Szuminski, 2003). One study showed that educators learned better when they were working in teams and helping to teach one another (Caverly et al., 1997).

In a similar model, a learner-centered design is promoted as a way to support teachers spanning the changes in technology, content and instructional technology available.

Maurer (2000) provided nine guidelines for developing a learner-centered model of professional development (PD). PD should:

- Focus on the technical content and issues students may have learning the material.

- Be driven by analysis of the difference between goals and standards for students and actual student performance.

- Help teachers understand their own learning process.

- Be integrated into school operations.

- Be organized around collaborative problem solving.

- Be continuous and ongoing.

- Incorporate evaluation.

- Provide theoretical understanding of content to be learned.

- Be integrated with comprehensive change programs to facilitate learning."
  (Maurer, 2000, p. 4).

While these models discuss general methods for professional development, the actual training portion can range from one-hour guest speakers through summer intensive programs or

even year-long learning communities. With online professional development offerings, both short-term and open-ended opportunities are available for teachers to increase pedagogical content knowledge in a global community of teachers (Carr, 2016). Collaboration with peers can be more effective than formalized professional development activities (Cordingley, 2015). Teachers found ongoing training and support during in-service time also seems effective for the integration of standards into curriculum and helped to create curriculum supporting standard of higher levels of critical thinking, which has shown to positively impact student learning and outcomes (Castellano et al., 2007).

Collaborative inquiry uses groups of teachers to share experiences to help eliminate teacher-identified knowledge gaps, discovered through classroom practice (Nelson et al., 2008). In this process, teachers will develop deeper competence over time with opportunities for "reflection, discussion, questioning, practice and feedback" (Nelson et al., 2008, p. 1272). In one study ongoing mentoring throughout the year led to higher teacher satisfaction and increased teacher retention (Bottoms et al., 2014). In another study, Slick (2002) found that by creating a learning community to work toward common goals, the teachers were able to collaborate more easily, validate working strategies, share more effectively, and increase their personal motivation for professional activities. Overall, the study found a higher level of career satisfaction for the teachers, as well as an increase in professional growth.

2.5   Online Professional Development

While teachers may benefit from professional development and may be motivated to pursue such opportunities, there are various barriers, making ongoing professional development difficult to implement. Barriers to professional development often include the daily demands of teaching,

keeping up with changing curriculum, classroom management and other time constraints (Bottoms et al., 2013; Nelson et al., 2008).

Online professional development provides opportunities to supply teachers with professional development addressing pedagogical content knowledge, new technologies, classroom management and various other topics that are relevant to the individual teacher's needs (Casale, 2011; Dede, 2016). Driven by the teacher's individual interest, the community of learners, whether local or global, can foster new support networks of best practices in classroom settings (Carr, 2016). Support networks also promote ongoing collaboration and sharing of resources, beyond the specified duration of the formal professional development workshop, creating in-service peer support, rarely found in face-to-face workshops (Castellano et al., 2007). In one study, 91 percent of participants in an online professional development course (n=120), participants increased collaboration with colleagues, supporting sustained development experiences through collaboration (Whitehouse et al., 2002). Relevant content and peer collaboration have been categorized as best practices for professional development, regardless of modality (Bangert, 2004; Banks, 2008; Barlow et al. 2014; Bottoms et al. 2013; Casale, 2011; Dede 2016).

Online professional development also increases accessibility through self-paced and asynchronous activities that would not be possible in a face-to-face format (Carr, 2016; Schoenbach et al., 2016). Online professional development also offers opportunities for self-directed learning, echoing previous research on the benefits of a constructivist approach to professional development (Bangert, 2004; Kleiman and Wolf, 2016). In another study with national enrollment of teachers for voluntary professional development, 84 percent of participants (n = 7,038) enrolled due to the flexibility of the course (Ramsdell, Rose & Kadera,

2002). Dash et al. (2012) also noted that online professional development promotes the ability to balance professional development activities amidst other professional demands.

2.6   Previous Research and Assessment of Online Professional Development

While online professional development seeks to take advantage of scalability and access, not all methods work for all teachers. Professional development must blend sound research-based insights with the wisdom of practical implementation to bridge the gap between the goals of the professional development and what teachers implement in the classroom (Dede, 2016). Online professional development provides teachers with asynchronous support, as well as increased communities of practice, overcoming barriers previously identified. For example, Carr (2016) found that participants separated by large geographic distances were found to have authentic community-based professional development through various online media. Success factors identified in this study included collaborative inquiry, integration with local processes, reflective conversation, technical support, support by other educators and facilitators. The researchers discovered that online professional development fostering increased participation through shared communication with peers received positive feedback. Another study indicated that online professional development allows for professional development anytime, anywhere, providing teachers an opportunity to access opportunities while balancing work and other responsibilities (Dash et al., 2012). However, when measuring effectiveness, comparisons were limited to instructors who received online professional development and instructors who received no professional development during the same time frame.

Klienman and Treacy (2002) offered nationwide online professional development to teachers with a focus on:

- fostering a deepening of subject-matter knowledge

- encouraging critical thinking activities

- including case-based learning,

- encouraging collaboration between peers (p. 38)

Over 90 percent of participants included in the online professional development experience gave positive feedback on the experience.

However, current research acknowledges the difficulty of quantifying the effectiveness of online professional development (Dash et al., 2012; Desimone, 2009). While studies have shown some teachers prefer online professional development, the data is often gathered through surveys or interviews with participants who volunteered for the study (Desimone, 2009; Whitehouse et al., 2002). As such, ongoing research that addresses efficacy of online professional development compared to face-to-face professional development would be beneficial as school systems consider making online professional development their primary platform (Sahr, 2016).

2.7   Instruments for Assessing Professional Development

Assessment is a critical component of both the experimental design and of the research methodology, as assessment is being used as one of the measurements of effectiveness for professional development. Therefore, research must be grounded on both appropriate experimental design, based on the research questions, and on best practices in assessing effective learning.

In this section, each of the three research questions and the corresponding assessment instruments are discussed with respect to relevant supporting literature.

2.7.1   Research Question One

Is online professional development as effective as face-to-face professional development for training teachers in the content associated with LOGM 127 (Introduction to Logistics)?

The first research question compared effectiveness of professional development for training teachers in the content of LOGM 127 using face-to-face methods compared to online modalities. To investigate this question, one must first establish what is meant by effective professional development. To do this, previous research studies which have established characteristics of effective professional development were consulted. Loucks-Horsley et al. (1998) described effective professional development stating that professional development:

- Is designed to address student learning goals and needs

- Is driven by a well-defined image of effective classroom teaching and learning

- Provides opportunities for teachers to build their content and pedagogical content knowledge and reflect on practice

- Is research based and engages teachers in the learning approaches they will use with their students

- Provides opportunities for teachers to collaborate with colleagues and other experts to improve their practice

- Helps teachers develop their professional expertise to serve in leadership roles

- Links with other parts of the educational system

- Is continuously evaluated and improved (pp. 70 -71).

These characteristics are widely cited in other studies designing professional development, as well as reiterated by other researchers evaluating characteristics of effective professional development (Banks, 2008; Barlow et al., 2014; Baxter et al., 2014; Carr, 2016; Casalle, 2011;

Castellano et al., 2007; Cordingley, 2015; Dede, 2016; Edney, 2010; Keheller, 2003; Maurer, 2000; Osler, 2013; Slick 2002; Stephens, 2012; Visser et al., 2012).

Once establishing characteristics of effective professional development strategies, a scientifically sound method for comparison must be established. To compare effectiveness between online professional development and face-to-face professional development, using identical content, requires an assessment of knowledge. Desimone (2009) explains that, "measuring the effect of PD is analogous to measure the quality of a teachers' learning experience" (p. 188). To compare the two methodologies, this study uses a quasi-experimental design using a pretest/posttest with an experimental group and a control group methodology. Dick, Carey and Carey (2015) recommend this methodology to assess learning (p. 140). Dash et al. (2012) used a quasi-experimental methodology when examining the effectiveness of online professional development in mathematics.

In choosing an appropriate tool for the pretest/posttest methodology, Sekaran (2003) explain that learning can be addressed from an operationalized context through "understanding, retention and application" (p. 182) and that multiple-choice tests can demonstrate understanding and retention. Dick et al. (2015) recommended that goal-centered criteria for evaluating existing materials include: congruence between the content in the materials and your terminal and performance objectives, adequacy of content coverage and completeness, authority, accuracy, currency and objectivity" (p. 260). Therefore, an appropriate assessment instrument to measure effectiveness in professional development regarding the LOGM 127 (Introduction to Logistics) course would be directly aligned with the content and performance objectives for that course. For this reason, the statewide standardized end-of-course assessment (ECA) was selected as the pretest/posttest measurement for the first research question.

2.7.2   Research Question Two

Is online professional development as effective as face-to-face professional development for preparing teachers for the Manufacturing Skills Standards Council (MSSC) Certified Logistics Associate (CLA) certification?

The second research question addresses the adequacy of the professional development as preparation for the Manufacturing Skills Standards Council (MSSC) Certified Logistics Associate (CLA) certification. The MSSC CLA certification is a nationally recognized, industry credential, which has been accredited by the ANSI ISO 17024 standard (MSSC, 2016). In 2009, subject matter experts created the CLA credential to recognize a body of knowledge required for entry-level logisticians. The CLA certification exam has been tested for reliability and validity through statistical analysis and been adopted by numerous federal agencies for assessing foundational logistics knowledge (MSSC, 2016). The studies establishing reliability and validity have not been published and were not accessible from MSSC. However, the CLA credential has been used in training programs in 28 states, issuing over 15,000 credentials nationwide (MSSC, 2017). The credential was also chosen by the U.S. Army for training 4,300 active duty service men and women in the U.S. Army Quartermaster Corps (MSSC, 2016). It was also embedded in the LOGM 127, Introduction to Logistics statewide course by Ivy Tech Community College as a cumulative assessment, dictated by the statewide course outline of record (Ivy Tech Community College, 2015). The course outline also reflects alignment between course objectives and the MSSC body of knowledge. As per Ivy Tech Community College faculty credentialing standards (7.1), faculty teaching a course with an embedded certification must also hold that certification to be credentialed to teach the course (Ivy Tech Community College, 2017). For these reasons,

successful completion of the MSSC CLA certification exam is a critical area of professional development for any instructors teaching LOGM 127.

2.7.3   Research Question Three

How do teachers rate the effectiveness of each component of the online professional development course?

The third research question pertained to teacher's view of the effectiveness of the professional development. To address research question three, an established questionnaire was selected which has been validated by previous research to accurately represent learner perceptions on instructional experiences. The tool, the Student Evaluation of Online Teaching Effectiveness (Bangert, 2004), was employed in multiple validation studies with learners from various disciplines at institutions nationwide (Bangert, 2008). Both statistical validation studies and confirmatory factor analysis were conducted on the survey instrument. Both six-point Likert scale responses and open-ended questions are integrated into the survey instrument (Bangert, 2008). The 26-item survey demonstrated internal consistency reliabilities exceeding 0.80 and coefficient alphas for the four defined factors ranging from 0.82 to 0.94 (Bangert, 2008). While oriented towards online coursework, this tool was based on effective teaching practices established by previous educational research. Additionally, the questions included in the survey align with core components of professional development areas previously established by the work of Desimone (2009).

Whitehouse et al. (2002) conclude that both empirical evidence of increases in teachers' content knowledge and understanding of teacher expectations through teacher evaluations are required for understanding of effective professional development. Creswell (2009) also asserts that the blend of quantitative and qualitative data aids in forming a "comprehensive analysis of

the research problem" (p. 14). Questionnaires and surveys about a learner's experience are also considered to be a key component in formative assessment strategies (Dick, et al., 2015; Reigeluth, Beatty, & Myers, 2017).

2.8   Summary

While research shows that the most effective methods for professional development are long-term, mentor and peer-based communities of learning, the barriers for time to address pedagogical content knowledge and opportunities for ongoing collaboration remains. Career and technical educators face additional challenges with higher proportions of special needs students, embedded industry credentials, and the expectation to help fund classroom needs through the use of grants. For those teachers who have completed formal CTE teacher training programs, gaps in subject matter content can cause a lack of confidence in teaching and lead to a lack of rigor and relevance in the classroom. However, alternatively certified CTE teachers often lack knowledge of basic pedagogy and classroom management skills.

Online professional development based on established practices for effective professional development experiences could help to address these areas of concern. However, establishing a methodology for assessing the effectiveness of online professional development, compared to face-to-face professional development remains an area requiring additional study. This study seeks to gain insight into the effectiveness of online professional development using mixed-methods research, based on previously validated assessment instruments.

CHAPTER 3.   METHODOLOGY

The study aimed to provide qualitative and quantitative evidence to the effectiveness of online professional development for technical educators through the following research questions:

1. Is online professional development as effective as face-to-face professional development for training teachers in the content associated with LOGM 127?

2. Is online professional development as effective as face-to-face professional development for preparing teachers for the Manufacturing Skills Standards Council (MSSC) Certified Logistics Associate (CLA) certification?

3. How do teachers rate the effectiveness of each component of the professional development course?

To investigate these questions, the researcher evaluated professional development efforts associated with a National Science Foundation Advanced Technological Education (NSF ATE) grant (award number 1304619). Grant award 1304619 included specific funding dedicated to the creation of an educational pathway in logistics from high school coursework through a four-year college degree. By creating an educational pathway from high school through college, training supported employment opportunities direct from high school, certificate programs from the community college, and bachelor-level positions.

The program from high school to community college required acceptance from the Indiana Department of Education (IDOE) to approve the curriculum objectives and integrate the course into an established career and technical education pathway. The IDOE provides funding support to school districts offering coursework that supports high-wage career paths (IDWD, 2018). The IDOE deemed the field of logistics as a high-growth, high-wage career pathway and, therefore,

qualifying for the funding support to schools offering college level coursework that earned credit at both Ivy Tech Community College and their high school (Fleck, 2017). Dual-credit coursework supports the technical diploma requirements established by the IDOE, which included industry-recognized certifications aligned to the dual-credit course objectives (IDOE, 2018-B). The IDOE selected the Manufacturing Skills Standards Council Certified Logistics Associate certificate as one of the industry-recognized credentials included in the logistics pathway.

To meet grant objectives, Ivy Tech Community College collaborated with Purdue University in the creation of professional development opportunities for technical educators teaching LOGM 127 (Introduction to Logistics) at both the high school and community college levels. The professional development addressed both subject matter content and pedagogical techniques to deliver content aligned with the LOGM 127 course. Grant personnel previously offered this training as a face-to-face, multi-day workshop. In effort to increase accessibility to teachers around the State of Indiana, grant personnel created an online version for the professional development using the Canvas Instructure Learning Management System (LMS) to create open source content available to high school and college instructors statewide. Canvas Instructure is an open-source, free online Learning Management System, which can support online coursework available to anyone, regardless of their originating institution. The professional development course was designed to cover LOGM 127 content as well as prepare instructors to complete the MSSC CLA certification exam. This established professional development course served as the setting for the research activities.

3.1   Teacher Training Workshop Implementation

Research activities took place from February – June 2018, during the Ivy Tech Community

College 2018 Supply Chain Management and Logistics Teacher Training Workshop. Participants

registered for the course via a Google Event Registration online survey, which was emailed to

distribution lists for high school technical educators and business instructors within the Ivy Tech

Community College network of campuses (see Appendix B and C). The registration form

allowed participants to select either a face-to-face workshop hosted in Indianapolis on February

17 - 18, 2018 or an asynchronous online course available from February 5, 2018 through May

31, 2018. NSF ATE grant #1304619 reimbursed all travel costs for the face-to-face workshop.

Grant funds also provided classroom materials supporting activities taught as part of the

professional development, to those participants who completed the training activities. The grant

also provided funds to support the registration and certification costs associated with the MSSC

CLA certification exam. Both face-to-face and online participants who completed the training

requirements and took the MSSC CLA certification exam received compensation via a stipend of

$500.00.

Registration for the course was voluntary and participants self-selected either the face-to-face

workshop or the asynchronous online modality. All participants had access to the online

materials, via Canvas Instructure online Learning Management Software (LMS). All

participants, who volunteered to participate and accepted the training requirements, were

informed that they could withdraw from the course at any time.

All participants received an overview of training requirements, including the review of

curriculum for LOGM 127 (Introduction to Logistics), the review of supplementary course

activities, and the review of content associated with the MSSC CLA certification exam.

Participants of the training were required to complete both a pretest and a posttest, using the

LOGM 127 statewide end-of-course assessment to demonstrate competency of the course

curriculum. Participants were also required to complete the MSSC CLA certification exam,

which is required for all instructors of the LOGM 127 course. Participants completed an online

survey of their professional development experience using Qualtrics software.

All participants received both a timeline and sequence for training, highlighting the required

elements. The sequence for training included:

- Completion of the participant acknowledgement form, stating that they were taking part

  in an NSF ATE grant-sponsored activity and that data would be collected from the

  pretest, posttest, MSSC CLA certification and Qualtrics survey for further analysis (see

  Appendix D).

- Account registration using Canvas Instructure LMS.

- Completion of the pretest participant course content assessment.

- Review of provided materials, either self-paced using the asynchronous online course or

  by attending the face-to-face workshop.

- Completion of the posttest participant course content assessment.

- Completion of the MSSC CLA certification exam.

- Completion of the Qualtrics survey of the teacher-training experience.

3.2   Instrumentation

As discussed in the literature review, this study makes use of a mixed-methods format,

blending both qualitative and quantitative assessment strategies. Mixed methods research blends

both quantitative and qualitative research methods to provide a broad perspective on a given

situation (Serakan, 2015). The quantitative part of the experiment uses a quasi-experimental

pretest/posttest with a non-randomized group of online participants compared with a group of face-to-face participants, as well as a comparison of performance of all participants on the MSSC CLA certification exam. The qualitative measures include a survey with Likert-type response questions and an open-ended response for analysis.

The assessment tools used to investigate the effectiveness of online professional development are as follows:

1. LOGM 127 (Introduction to Logistics) statewide standardized end-of-course assessment (ECA). The assessment was designed and approved by the Ivy Tech Community College statewide curriculum committee and is administered at the end of each course, including dual-credit courses offered in the high school, face-to-face courses offered on Ivy Tech Community College campuses and online courses offered by Ivy Tech Community College. This ECA served as the pretest/posttest comparison, establishing baseline knowledge and knowledge gained through the professional development processes. Ivy Tech Community College was contacted for reported measures of validity and reliability of this test, but no response was received from the institution. However, the ECA assessment tool has been approved annually by the Ivy Tech Community College Statewide Curriculum Committee, been accepted by the Supply Chain Management Industrial Advisory Board and administered to over 1,000 students each year (Ivy Tech Community College, 2018). Based on the extensive usage and review by both course content subject matter experts and industry representatives, this instrument was deemed acceptable through content and face validity (Sprinthall, 2000). Pretest/posttest designs have major threats to validity with interactive testing effects and mortality (Serekan & Bougie, 2013). Interactive testing effects could potentially limit generalizability to the

population, however, as the professional development had the explicit goal of preparing for teaching LOGM 127 content, this effect is not applicable to the study. Mortality effects were experienced, as six individuals who took the pretest did not take the posttest. However, those individuals were not included in the statistical analysis of research question one, thereby mitigating the impact of this threat to validity. The ECA was hosted on the Canvas Instructure Learning Management System.

2. Manufacturing Skills Standards Council (MSSC) Certified Logistics Associate (CLA) certification exam. The CLA is a national certification designed and approved by logistics industry subject matter experts and is accredited by the ANSI ISO Standard 17024. The Manufacturing Skills Standards Council provided no additional reliability or validity information for the CLA certification exam. However, the exam has been used to credential over 15,000 individuals nation-wide in the past eight years, with an additional military personnel population totaling over 4,000 service members (MSSC, 2016; MSSC, 2017). The widespread adoption of this credential by government, industry and educational institutions provides sufficient content and face validity (Sprinthall, 2000). From an experimental design perspective, this test is equivalent to a "posttest only, equivalent group design" which is considered robust against threats to experimental validity (Best & Kahn, 2006).   LOGM 127 embeds the CLA certification exam into the course and is a requirement for faculty credentialing to teach this course (Ivy Tech Community College, 2017). This assessment was administered electronically through MSSC certified assessment centers throughout the state of Indiana.

3. Student Evaluation of Online Teaching Effectiveness (SEOTE) survey. The SEOTE survey (Bangert, 2004) is a 26-item survey with demonstrated internal consistency

reliabilities exceeding 0.80 and coefficient alphas for the four defined factors ranging from 0.82 to 0.94 (Bangert, 2008). Key word analysis evaluated emerging themes for the open-ended questions. The SEOTE survey was administered through Qualtrics, an online survey software (see Appendix E).

3.3   Population and Sample

3.3.1   Population

The population for this study included all full-time and adjunct instructors for the School of Business at Ivy Tech Community College and all business instructors registered as dual-credit instructors at Indiana high schools. Ivy Tech Community College offers Supply Chain Management at 27 locations across the state of Indiana and employs 409 full-time and part-time instructors. The Indiana Department of Education (IDOE) offers dual-credit course work at 130 high schools throughout the state of Indiana. It is estimated that the available population was approximately 540 individuals, as larger high schools often have more than one business dual-credit instructor.

3.3.2   Sample

Initial registration for the training totaled 108 individuals from the email distribution lists to high school dual-credit business instructors and full-time and adjunct community college business instructors. Participants identified themselves in the Google Event Registration form as either high school business instructor or a community college business instructor and selected their preferred modality for training. Of those 108 initial registrations, 81 individuals began the training process by logging into the Canvas Instructure course and completing the required pretest. While the training is specific to introductory concepts in logistics, the sample size is

approximately 10 percent of the population, with variety in institution, gender, work experience

and teaching history, making the results of this study acceptable for generalization to the

populations teaching this course, through criteria of population validity (Gall, Gall & Borg,

2007).

Instructors for this course were from a wide variety of locations within the state of Indiana

and taught at either a high school or at the regional Ivy Tech Community College campus. The

demographics for the instructors, including years of experience in teaching, years of industry

experience and years of experience teaching logistics courses are listed in Table 1. Demographic

questions were included to better understand the breadth of experience of those participating in

the professional development. The characteristic, frequency and percentage are presented in

Table 1.

Table 1. Demographic Characteristics of Participants (n=54)

Demographic Characteristics of Participants			
	Characteristic	Frequency of Response	Percent
Gender	Female	35	64.80%
	Male	19	35.20%
Institution	Community College	31	57.40%
	High School	23	42.60%
Teaching Experience (years)	0-2	8	14.80%
	2-5	9	16.70%
	>5	37	68.50%
Industry Experience (years)	0	22	40.70%
	<1	3	5.60%
	>1	29	53.70%
Teaching Logistics (semesters)	0	38	70.30%
	1-2	2	3.70%
	>2	14	26%

Table 1 shows that while many participants (68.5%) have taught for more than 5 years, most participants (70.3%) had not taught any logistics coursework prior to attending the training. Twenty-six percent of participants taught coursework within the logistics curriculum, but had not yet taught LOGM 127 which, which requires all instructors to complete the MSSC CLA certification exam prior to teaching the course. Approximately half of the participants (53.7%) had over a year of logistics industry experience, while the other half of participants (46.3%) had either zero or less than one year of industry experience.

Participant mortality was identified in the limitations of this study as a potential threat to validity. However, data analysis only included those subjects who completed all required elements of the training. Therefore, the mortality rates do not impact the results of this study. Table 2 displays the mortality rates for the participants based on instructional format.

Table 2. Participant Mortality

Participant Mortality			
Modality	Initial Participation	Number of Non-Completers	Mortality Rate
Online	54	24	44.44%
F2F	27	3	11.11%

For participants who selected asynchronous online training, all training materials, guides and activities were provided through the Canvas Instructure LMS. For those who selected face-to-face training, the same tools and resources were made available through the Canvas Instructure LMS. However, participants also attended a two-day workshop, which allowed them to take part in course activities and receive guided instruction regarding the MSSC CLA certification test preparation and LOGM 127 course content. Table 3 displays the participants institutional level and selected training modality.

Table 3. Participant Training by Instructional Level and Course Modality (n=54)

Participant Training by Instructional Level and Course Modality			
	High School Instructors	Ivy Tech Community College Instructors	Total
Online	16	14	30
F2F	7	17	24
Totals	23	31	54

3.4   Data Collection

Canvas Instructure served as the platform for administering the pretest and posttest, using the

Ivy Tech LOGM 127 end-of-course assessment (ECA). Participants were required to log into

Canvas Instructure LMS and take the pretest prior to accessing any other course materials. The

posttest was available to the participants through Canvas Instructure and accessible at any time

after the participant reviewed the course content. The Canvas Instructure LMS hosted all course

materials associated with LOGM 127. It also contained professional development materials

regarding recommended activities and pedagogy specific to the LOGM 127 course. The Canvas

Instructure LMS also hosted a section dedicated to preparation for the MSSC CLA certification

exam. All participants were provided with a guide for navigating the various content sections of

the professional development course, however, participants were not required to complete all

LOGM 127 course activities as part of the training. Each participant was able to select how much

time to spend on each content area, based on their perceived need. The researcher downloaded

the scores for the pretest and posttest from Canvas Instructure in a csv file, and saved the data in

a Microsoft Excel workbook for analysis.

Numerous locations throughout the state of Indiana offer the MSSC CLA certification exam.

All testing sites must register with MSSC and obtain permission to host the computer-based

exam. Participants selected a testing site and completed the certification exam. Registration costs and exam costs for the participants were funded through the NSF ATE grant. An Ivy Tech Community College testing coordinator recorded all exam results and saved the data in a Microsoft Excel workbook for analysis.

Qualtrics served as the online platform for distributing the SEOTE survey. Participants accessed the survey through a link provided in Canvas Instructure. Data were exported into a PDF document and a Microsoft Excel workbook for analysis.

The posttest, MSSC CLA certification exam and Qualtrics survey were taken at a time determined by the participant. Therefore, data collection occurred between February 2018 and June 2018, with scores being submitted electronically through the specified platform. Posttest scores were automatically saved in the Canvas Instructure course and accessible to the researcher for analysis. MSSC CLA certification exams were emailed to the researcher by the Ivy Tech Community College Lafayette Campus testing center. The Qualtrics survey results were recorded directly in the web-based software and were exported for analysis.

3.5 Data Analysis

Each research question yielded quantitative data from the instruments discussed above. The LOGM 127 ECA yielded a score for each participant for both a pretest and posttest. The difference of these two scores (posttest – pretest) was used for the data analysis of question one. The MSSC CLA certification exam yielded a score for each participant, which was used for the data analysis of research question two. The survey responses from the SEOTE survey had three types of responses. The first five items addressed demographic information and were presented in categorical format. Items six through twenty-three of the survey addressed various aspects of participant perceptions of the course experience and used a Likert-style response. The final item

was an open-ended response for comments from the participants. Frequency and percentage data were considered for the demographic items of the survey while non-parametric measures were used for the remaining Likert-style items. Data analysis of each research question is described in detail below. Analyses of collected data were based both on previous work in similar fields and basic statistical concepts regarding the analysis of quantitative data.

3.5.1   Research Question One

Research question one states, "Is online professional development as effective as face-to-face professional development for training teachers in the content associated with LOGM 127?" To address this question, data were collected using a "Pretest and posttest experimental and control group" design (Sekaran & Bougie, 2013, p.185) in which the treatment effect is measured by comparing the difference of the posttest and pretest scores of each group. While this experimental design can create an opportunity for mortality (Sekaran & Bougie, 2013), only those individuals who completed both the pretest and posttest, as well as the remaining activities of training process were considered. As such, mortality effects are limited. However, when data were collected, it was discovered that five individuals from the face-to-face group and one individual from the online group did not complete the posttest. This created a difference of 6 individuals from the sample for research question one (n=48) and the sample size of research questions of two and three (n=54). Maturation could be considered a threat to validity as individuals were able to test at any time within the training window of February 2018 to May 2018. This is true for both the experimental and the control group. Testing and instrumentation effects were controlled by providing the pretest to both groups of participants (Sekaran & Bougie, 2013). To determine if there was a difference between the means of the face-to-face participant group and online participant group, a one-way ANOVA with a significance level of

5% was used. This method is recognized as a valid statistical tool for samples that are independent, interval or ratio scale, normally distributed and have equal variances for the populations being evaluated (Groebner, Shannon, Fry & Smith, 2011, p. 477). Descriptive statistics are reported for each group.

3.5.2   Research Question Two

Research question two asks, "Is online professional development as effective as face-to-face professional development for preparing teachers for the Manufacturing Skills Standards Council (MSSC) Certified Logistics Associate (CLA) certification?" For this question, data were collected by obtaining MSSC CLA certification test scores from both the online participants and face-to-face participants. To determine if there was a difference between the means of the face-to-face participant group and online participant group, a one-way ANOVA with a significance level of $\alpha = 5\%$ was used. This method is recognized as a valid statistical tool for samples that are independent, interval or ratio scale, normally distributed and have equal variances for the populations being evaluated (Groebner, Shannon, Fry & Smith, 2011, p. 477). Descriptive statistics are reported for each group.

3.5.3   Research Question Three

Research question three asks, "How do teachers rate the effectiveness of each component of the professional development course?" To answer this question, all participants completed the SOETE survey through the Qualtrics platform. The SOETE survey made use of a six-scale Likert form, as modeled in the Bangert (2008) study. While there is some debate on the appropriate analyses of Likert-scale data (Gob, McCollin, & Ramalhoto, 2007), examples of treating the data as ordinal scale data and as interval data were presented in literature. Boone and Boone (2012) differentiate Likert scale data with Likert-type data, by stating that Likert data can

only be treated as interval scale data when four or more questions within a single content area of a survey combined into single composite scores (Boone & Boone, 2012, p. 2). Likert-type data is using a scale similar to the scale instrument developed by Likert, but each question is regarding one singular concept and cannot be grouped into a composite score. For Likert-type data, ordinal statistical tools are appropriate (Boone & Boone, 2012). Gob et. al. (2007) also state that, while commonly used as interval data in data analysis, Likert data is ordinal and should only be subjected to statistical analysis associated with ordinal scale data, such as frequency and median (Gob, et al., 2007, p. 602). Several studies using Likert-type scales for survey data regarding professional development have used the frequency, percentage of positive responses, and medians of the data to analyze and discuss their findings (Boots, 2013; Collins & Liang, 2015; Wu, 2014). In this study, six of the seven areas of focus in the survey instrument have fewer than four questions and a composite score cannot be calculated. Therefore, this study is more consistent with Likert-type data sets and the data were treated as ordinal. As such, a Mann-Whitney test was performed on each item of the survey to compare responses between the online group and face-to-face group. The Mann-Whitney test is a non-parametric analysis that requires ordinal level data and is not dependent on having normally distributed data (Field, 2013). As such, the Mann-Whitney is deemed appropriate based on the type of data collected through the survey.

This chapter discussed the population of participants, the testing methodology and instrumentation, the data collection and provided a rationale for the approach used to analyze the data.

CHAPTER 4.   RESULTS

This chapter presents the data gathered using the instruments described in chapter 3. For each

research question, analyses of the data are displayed below. Statistical data analyses were

conducted using IBM SPSS Statistics software (version 25). For statistical tests where a level of

significance of $\alpha = 0.05$ was used, which is consistent with research practices in this field. P-

values are reported and compared to $\alpha = 0.05$ for establishing statistical significance where

applicable. For the data gathered, descriptive statistics were calculated using IBM SPSS.

Additional analysis for comparing the two modality groups was conducted using a one-way

ANOVA.

Typically, an ANOVA can be performed if:

- Populations are normally distributed.

- Population variances are equal.

- Observations are independent.

- Data are interval or ratio level (Groebner, Shannon, Fry & Smith, 2011, p. 477).

Data gathered for research questions one and two were interval level and therefore met the

data-level requirement for ANOVA. Additionally, a one-way ANOVA is considered a robust

statistical test for data that violates the normality when one can confirm homogeneity of the

variances and demonstrate independence of the residuals (Montgomery, 2013). Homogeneity of

variance can be tested using Levene's test (Bower, 2000; Field, 2013; Montgomery, 2013).

Independence of the sample residuals can be tested using a normal probability plot

(Montgomery, 2013) and through the use of the Durbin Watson test (Field, 2013). Both research

question one and two make use of this approach for evaluating the quantitative data gathered for the study. Results from these tests are presented in sections 4.1 and 4.2.

4.1   Research Question One

Research question one states, "Is online professional development as effective as face-to-face professional development for training teachers in the content associated with LOGM 127?" To evaluate this question, participants completed a pretest and a posttest based on the end-of-course assessment for the LOGM 127 course. Although the researcher included directions to complete the posttest as part of the activities required for course completion, six individuals did not complete the posttest prior to the closure of the course. There were five individuals from the face-to-face group and one individual from the online group which did not take the posttest. Therefore, the sample for research question one was n=48 (19 face-to-face and 29 online), rather than the 54 who completed the MSSC CLA certification exam and the online Qualtrics survey. While completion of the pretest was required to have access to the training materials, the posttest could be accessed anytime throughout the duration of the training. The lack of participation of these individuals was not discovered until the course activities ended and the data were downloaded for analysis.

To measure if online professional development was as effective as face-to-face professional development, the difference between the posttest and pretest scores of the LOGM 127 end-of-course assessment were compared for both the face-to-face participants and online participants. The difference was calculated by subtracting the pretest score from the posttest score. The result was a difference score (posttest-pretest), from which descriptive statistics were calculated. The difference scores were also evaluated for normality, homogeneity of variance and independence. Table 4 shows the descriptive statistics for all 48 participants (PostPreAll) combined, the group

of 19 face-to-face participants who took both the posttest and the pretest (PostPreF2F) and the

group of 29 online participants who took both the posttest and the pretest (PostPreOnline).

Table 4. Descriptive Statistics - Difference Between Posttest and Pretest (n=48)

Descriptive Statistics - Difference Between Posttest and Pretest								
					Skewness		Kurtosis	
	n	Mean	Std. Dev.	Variance	Statistic	Std. Error	Statistic	Std. Error
PostPreAll	48	3.6042	6.01678	36.202	.722	.343	.250	.674
PostPreF2F	19	3.8421	5.77603	33.363	.000	.524	-.449	1.014
PostPreOnline	29	3.4483	6.26547	39.256	1.119	.434	.855	.845

Normality. Both a test for normality and a normality plot were conducted prior to additional

statistical analysis. Kolmogorov-Smirnov and Shapiro-Wilk are available in SPSS for testing of

normality and include the option of graphing the normal quartile-quartile plot (Q-Q plot) (Field,

2013). Table 5 show the results of the test for normality. The Q-Q plot for the difference

between the posttest and pretest is displayed in Figure 1.

Table 5. Test for Normality - Difference Between Posttest and Pretest (n=48)

Tests of Normality – Difference Between Posttest and Pretest						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
PostPreall	.144	48	.014	.952	48	.049
a. Lilliefors Significance Correction						

Figure 1. Normal Q-Q Plot of Difference Between Posttest and Pretest (n=48)

The *p-value* = 0.049 is smaller than the desired α (α = 0.05), however, Bower (2000), Field (2013) and Montgomery (2013) all speak to the robustness of the ANOVA test, even in situations where the data are not normally distributed, given that the other assumptions for the ANOVA are upheld.

Homogeneity of Variance. To test the homogeneity of the variance, Levene's test was conducted using IBM SPSS. The results of Levene's test are documented in Table 6.

Table 6. Levene's Test of Difference Between Posttest and Pretest (n=48)

Levene's Test of Difference Between Posttest and Pretest		Levene Statistic	df1	df2	Sig.
PostPreall	Based on Mean	.068	1	46	.795
	Based on Median	.000	1	46	.993
	Based on Median and with adjusted df	.000	1	44.016	.993
	Based on trimmed mean	.008	1	46	.931

Table 6 confirms the homogeneity of variance for a *p-value* = 0.795, which is greater than α

=0.05.

Independence. A normal probability plot (P-P plot) to test the independence of the error terms

and a Durbin Watson test were performed to determine if there was serial correlation between

the errors (Field, 2013). For two regressors and a sample size of 48, the Durbin Watson score

should be greater than 1.57762 to confirm that there is no serial correlation of the error (Minitab,

2017). The Durbin Watson statistic was calculated to be 1.60, which is greater than the Durbin

Watson upper limit ($D_{UL, 0.05}$ = 1.57762) at a 5% level of significance. Therefore, the

independence assumption is confirmed. The normal P-P plot of the residuals is presented in

Figure 2.
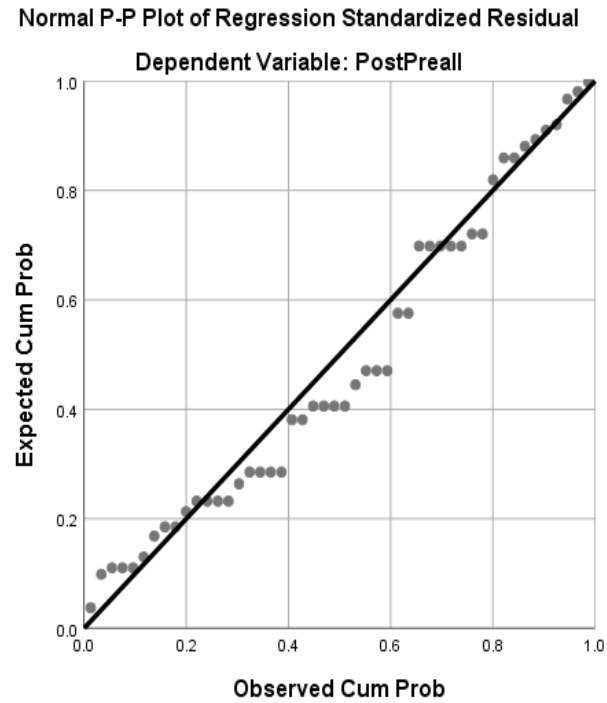
Figure 2. Normal Probability Plot Difference Between Posttest and Pretest (n=48)

Having satisfied the assumptions for homogeneity of variances and independence, a one-way ANOVA was performed to determine if the means of the difference scores for the online modality differed from those of the face-to-face modality. The results of the ANOVA are recorded in Table 7.

Table 7. One-way ANOVA for Difference Between Posttest and Pretest (n=48)

One-way ANOVA for Difference Between Posttest and Pretest					
PostPreall	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.780	1	1.780	.048	.827
Within Groups	1699.699	46	36.950		
Total	1701.479	47			

With a *p-value* = 0.827, which is greater than α = 0.05, it was determined that the mean

difference scores for the online modality and face-to-face modality are not significantly different.

Additionally, the Cronbach alpha for the administration of the posttest was 0.855635.

4.2   Research Question Two

Research question two states, "Is online professional development as effective as face-to-face

professional development for preparing teachers for the Manufacturing Skills Standards Council

(MSSC) Certified Logistics Technician (CLA) certification?" To evaluate this question,

participants of both the online and face-to-face groups took the MSSC CLA certification exam.

All 54 participants completed the MSSC CLA certification exam, with 30 individuals

participating in the online group and 24 individuals in the face-to-face group. The descriptive

statistics for the scores are reported in Table 8.

Table 8. Descriptive Statistics - MSSC CLA Exam Scores (n=54)

Descriptive Statistics - MSSC CLA Exam Scores								
					Skewness		Kurtosis	
	n	Mean	Std. Dev.	Variance	Statistic	Std. Error	Statistic	Std. Error
MSSC CLA Exam Scores - All	54	83.5630	5.76336	33.216	-.074	.325	-.169	.639
CLAF2F	24	82.8500	5.25928	27.660	-.182	.472	.587	.918
CLAOnline	30	84.1333	6.16533	38.011	-.108	.427	-.446	.833

Normality. Both a test for normality and a normality plot were conducted prior to additional

statistical analysis. Kolmogorov-Smirnov and Shapiro-Wilk are available in SPSS for testing of

normality and include the option of graphing the normal quartile-quartile plot (Q-Q plot) (Field,

2013). The results of the test for normality are seen in Table 9. The Q-Q plot for the MSSC CLA

Exam scores is displayed in Figure 3.

Table 9. Test for Normality - MSSC CLA Exam Scores (n=54)

Tests of Normality – MSSC CLA Exam Scores						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
MSSC CLA Exam Scores - All	.091	54	.200[*]	.991	54	.961
*. This is a lower bound of the true significance.						
a. Lilliefors Significance Correction						
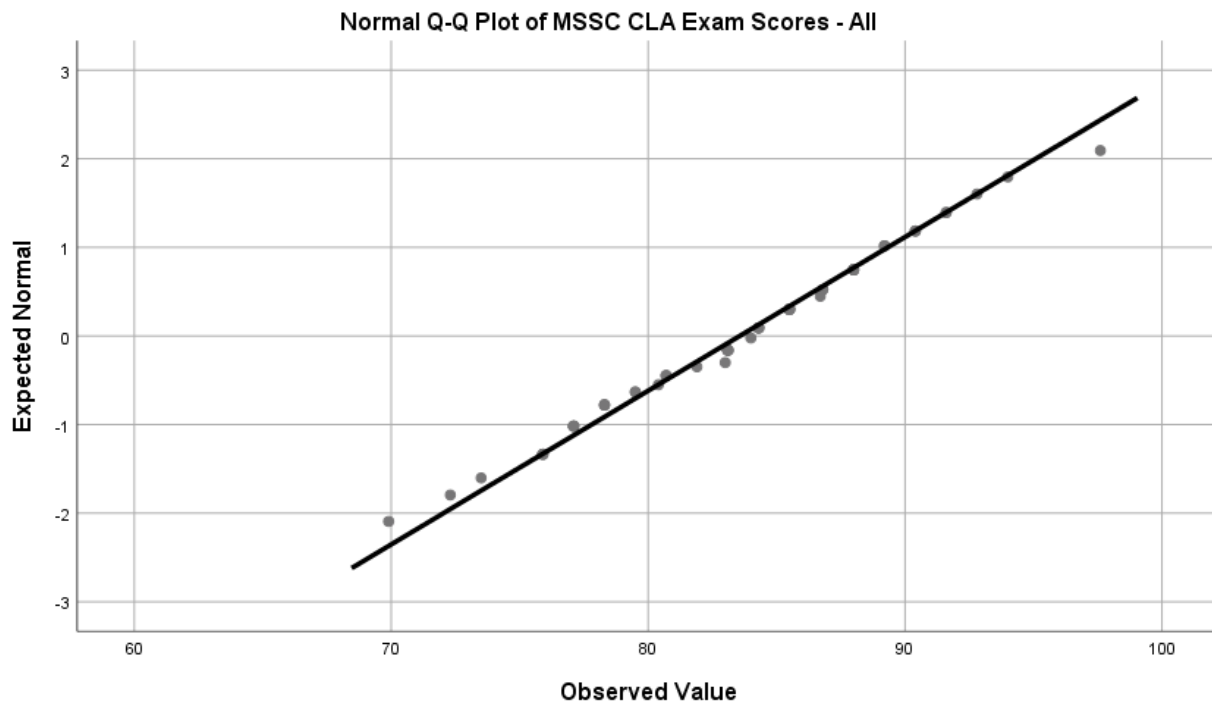
Figure 3. Normal Q-Q Plot of MSSC CLA Exam Scores (n=54)

These tests confirm the normality of the data.

Homogeneity of Variance. To test the homogeneity of the variance, Levene's test was

conducted using IBM SPSS. The results of Levene's test are documented in Table 10.

Table 10. Levene's Test of MSSC CLA Exam Scores (n=54)

Levene's Test of MSSC CLA Exam Scores		Levene Statistic	df1	df2	Sig.
MSSC CLA Exam Scores - All	Based on Mean	1.066	1	52	.307
	Based on Median	.808	1	52	.373
	Based on Median and with adjusted df	.808	1	50.861	.373
	Based on trimmed mean	1.095	1	52	.300

Table 10 confirms the homogeneity of variance for a *p-value* = 0.307, which is greater than α =0.05.

Independence. As with research question one, a normal probability plot (P-P plot) to test the independence of the error and a Durbin Watson test were performed to determine if there was serial correlation between the errors (Field, 2013). For two regressors and a sample size of 54, the Durbin Watson score should be greater than 1.59829 to confirm that there is no serial correlation of the error (Minitab, 2017). The Durbin Watson statistic was calculated to be 2.044, which is greater than the Durbin Watson upper limit ($D_{UL, 0.05}$ = 1.59829) at a 5% level of significance. The test results confirm the assumption of independence. The normal P-P plot of the residuals is presented in Figure 4.

Normal P-P Plot of Regression Standardized Residual

Dependent Variable: MSSC CLA Exam Scores - All
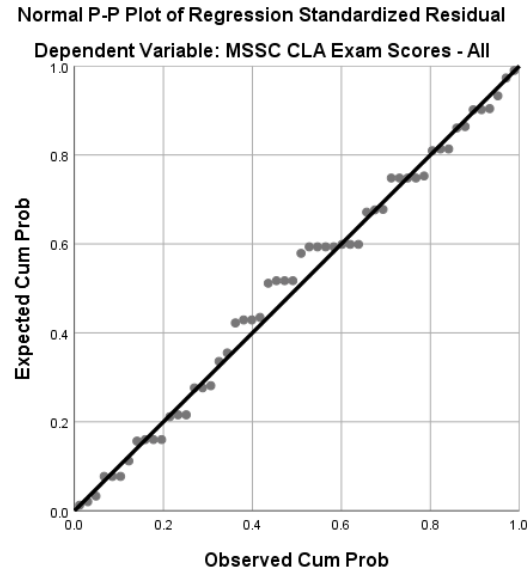
Figure 4. Normal Probability Plot of MSSC CLA Exam Scores (n=54)

Having satisfied the assumptions for normality, homogeneity of variances and independence, a one-way ANOVA was performed on the data to determine if the means of the MSSC CLA certification exam scores for the online modality differ from those of the face-to-face modality. The results of the ANOVA are recorded in Table 11.

Table 11. One-way ANOVA for MSSC CLA Exam Scores (n=54)

One-way ANOVA for MSSC CLA Exam Scores					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	21.959	1	21.959	.657	.421
Within Groups	1738.507	52	33.433		
Total	1760.466	53			

With a *p-value* = 0.827, which is greater than α = 0.05, it was determined that the mean difference scores for the online modality and face-to-face modality are not significantly different.

It was impossible to establish reliability data for the sample, as the test content is proprietary in nature and not made available to the researcher.

4.3   Research Question Three

Research question three states, "How do teachers rate the effectiveness of each component of the professional development course?" To evaluate this question, all participants completed the Student Evaluation of Online Teaching Effectiveness (SEOTE) survey (Bangert, 2008) through the online survey software, Qualtrics. The SEOTE survey used a 6-item Likert response format including (1) Strongly Agree, (2) Agree, (3) Mildly Agree, (4) Mildly disagree, (5) Disagree, (6) Strongly Disagree; as modeled by Bangert's (2008) original survey. An additional category, Not Applicable, was added, to provide participants with a valid option for items they deemed inapplicable for their experience. The survey had 23 items in total. Five items were related to demographics and the remaining 18 items were divided into seven different constructs: Student Faculty Contact; Cooperation Among Students; Active Learning; Prompt Feedback; Time on Task; High Expectations; Diverse Talents and Ways of Learning. The demographic responses were displayed previously in Table 2. The remaining survey items, as well as frequency of response, for both online and face-to-face participants are organized by the seven constructs of focus below. Additionally, a Mann-Whitney test was performed to see if the online and face-to-face groups were distributed similarly. Those results are presented, by item, in the following sections.

4.3.1   Construct One – Student Faculty Contact

The first construct focused on interaction between the students and the instructor. The construct, Student Faculty Contact, contained four items. The items and response data are

presented in Tables 12 - 15. Figures 5 - 8 show the results of the Mann-Whitney test for each

item.

4.3.1.1.1 Construct 1 - Item 1 (Instructor Communication)

The instructor communicated effectively.

Table 12 records all responses to the item addressing instructor communication.

Table 12. SEOTE Survey Responses - Instructor Communication

| | Item 1: Instructor Communication | | | |
| | F2F | | Online | |
	Freq	%	Freq	%
Strongly Agree (1)	18	75	12	40
Agree (2)	4	16.6	15	50
Mildly Agree (3)	1	4.2	2	6.7
Mildly Disagree (4)	0	0	1	3.3
Disagree (5)	1	4.2	0	0
Strongly Disagree (6)	0	0	0	0
Not Applicable (NA)	0	0	0	0
No Response	0	0	0	0
Total	24	100	30	100

Figure 5 displays the results from the Mann-Whitney test on item 1 comparing the responses of

the online group and the face-to-face group.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Q6All is the same across categories of Q6Mod.	Independent-Samples Mann-Whitney U Test	.023	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 5. Mann-Whitney - Construct 1 - Item 1

With a *p-value* = 0.023 < α = 0.05, it was determined that the responses from the online group

and face-to-face group are not distributed similarly.

4.3.1.1.2 Construct 1 - Item 2 (Enthusiasm)

The instructor was enthusiastic about online teaching.

Table 13 records all responses to the item addressing instructor enthusiasm towards online

teaching.

Table 13. SEOTE Survey Responses - Enthusiasm

	Item 2: Enthusiasm			
	F2F		Online	
	Freq	%	Freq	%
Strongly Agree (1)	9	37.5	7	23.3
Agree (2)	9	37.5	16	53.4
Mildly Agree (3)	1	4.2	4	13.3
Mildly Disagree (4)	2	8.3	0	0
Disagree (5)	0	0	1	3.3
Strongly Disagree (6)	0	0	0	0
Not Applicable (NA)	3	12.5	2	6.7
No Response	0	0	0	0
Total	24	100	30	100

Figure 6 shows the results from the Mann-Whitney test on item 2 comparing the responses of the

online group and the face-to-face group.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Q7All is the same across categories of Q7Mod.	Independent-Samples Mann-Whitney U Test	.283	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 6. Mann-Whitney – Construct 1 – Item 2

With a *p-value* = 0.283 > α = 0.05, it was determined that the responses from the online group

and face-to-face group are distributed similarly.

4.3.1.1.3 Construct 1 - Item 3 (Accessible)

The instructor was accessible to me outside the course.

Table 14 records all responses to the item addressing instructor accessibility throughout the

professional development course.

<div align="center">Table 14. SEOTE Survey Response - Accessibility</div>

	Item 3: Accessibility			
	F2F		Online	
	Freq	%	Freq	%
Strongly Agree (1)	9	37.5	9	30
Agree (2)	12	50	16	53.3
Mildly Agree (3)	0	0	2	6.7
Mildly Disagree (4)	0	0	1	3.3
Disagree (5)	0	0	0	0
Strongly Disagree (6)	0	0	0	0
Not Applicable (NA)	3	12.5	2	6.7
No Response	0	0	0	0
Total	24	100	30	100

Figure 7 presents the results from the Mann-Whitney test on item 3 comparing the responses of

the online group and the face-to-face group.

Figure 7. Mann-Whitney - Construct 1 - Item 3

With a *p-value* = 0.253 > α = 0.05, it was determined that the responses from the online group

and face-to-face group are distributed similarly.

4.3.1.1.4 Construct 1 - Item 4 (Instructor Contact)

The amount of contact with the instructor was satisfactory (e.g., email, discussions, face-to-face meetings, etc.)

Table 15 records all responses to the item addressing the amount of instructor contact within the

course.

Table 15. SEOTE Survey Responses - Instructor Contact

| | Item 4: Instructor Contact | | | |
| | F2F | | Online | |
	Freq	%	Freq	%
Strongly Agree (1)	9	37.5	6	20
Agree (2)	14	58.3	18	60
Mildly Agree (3)	0	0	4	13.4
Mildly Disagree (4)	0	0	1	3.3
Disagree (5)	0	0	0	0
Strongly Disagree (6)	1	4.2	0	0
Not Applicable (NA)	0	0	1	3.3
No Response	0	0	0	0
Total	24	100	30	100

Figure 8 presents the results from the Mann-Whitney test on item 4 comparing the responses of

the online group and the face-to-face group.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Q9All is the same across categories of Q9Mod.	Independent-Samples Mann-Whitney U Test	.092	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 8. Mann-Whitney - Construct 1 - Item 4

With a *p-value* = 0.092 > α = 0.05, it was determined that the responses from the online group

and face-to-face group are distributed similarly.

4.3.2   Construct Two – Cooperation Among Students

The second construct focused on interaction amongst the students. The construct,

Cooperation Among Students, contained three items. The items and response data are presented

in Tables 16 - 18. Figures 9 - 11 show the results of the Mann-Whitney test for each item.

4.3.2.1.1 Construct 2 – Item 1 (Student Discussion)

The course was structured so that I could discuss assignments with other students.

Table 16 records all responses to the item addressing the students' interaction within the Canvas

Instructure LMS.

Table 16. SEOTE Survey Responses - Student Discussion

	Item 1: Student Discussion			
	F2F		Online	
	Freq	%	Freq	%
Strongly Agree (1)	12	50	5	16.7
Agree (2)	10	41.6	21	70
Mildly Agree (3)	0	0	1	3.3
Mildly Disagree (4)	0	0	0	0
Disagree (5)	1	4.2	3	30
Strongly Disagree (6)	0	0	0	0
Not Applicable (NA)	1	4.2	0	0
No Response	0	0	0	0
Total	24	100	30	120

Figure 9 presents the results from the Mann-Whitney test on item regarding the student

discussion item, comparing the responses of the online group and the face-to-face group.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Q10All is the same across categories of Q10Mod.	Independent-Samples Mann-Whitney U Test	.007	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 9. Mann-Whitney Construct 2 – Item 1

With a *p-value* = 0.007 < α = 0.05, it was determined that the responses from the online group and face-to-face group are not distributed similarly.

4.3.2.1.2 Construct 2 - Item 2 (Student Interaction)

I felt comfortable interacting with the instructor and other students.

Table 17 records all responses to the item addressing the students' comfort level with interaction within the Canvas Instructure LMS.

Table 17. SEOTE Survey Responses – Student Interaction

	Item 2: Student Interaction			
	F2F		Online	
	Freq	%	Freq	%
Strongly Agree (1)	15	62.5	9	30
Agree (2)	8	33.3	18	60
Mildly Agree (3)	0	0	2	6.7
Mildly Disagree (4)	1	4.2	0	0
Disagree (5)	0	0	0	0
Strongly Disagree (6)	0	0	0	0
Not Applicable (NA)	0	0	0	0
No Response	0	0	1	3.3
Total	24	100	30	100

Figure 10 presents the results from the Mann-Whitney test on item regarding the student interaction item, comparing the responses of the online group and the face-to-face group.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Q11All is the same across categories of Q11Mod.	Independent-Samples Mann-Whitney U Test	.031	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 10. Mann-Whitney - Construct 2 - Item 2

With a *p-value* = 0.031 < α = 0.05, it was determined that the responses from the online group and face-to-face group are not distributed similarly.

4.3.2.1.3 Construct 2 - Item 3 (Interactive Activities)

This course included activities and assignment that provided students with opportunities to interact with one another.

Table 18 records all responses to the item addressing the students' opportunities to interact with one another through activities and assignments within the Canvas Instructure LMS.

Table 18. SEOTE Survey Responses - Interactive Activities

	Item 3: Interactive Activities			
	F2F		Online	
	Freq	%	Freq	%
Strongly Agree (1)	15	62.5	6	20
Agree (2)	8	33.3	19	63.4
Mildly Agree (3)	0	0	2	6.7
Mildly Disagree (4)	0	0	1	3.3
Disagree (5)	1	4.2	1	3.3
Strongly Disagree (6)	0	0	0	0
Not Applicable (NA)	0	0	0	0
No Response	0	0	1	3.3
Total	24	100	30	100

Figure 11 presents the results from the Mann-Whitney test on item regarding the interactive activities item, comparing the responses of the online group and the face-to-face group.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Q12All is the same across categories of Q12Mod.	Independent-Samples Mann-Whitney U Test	.003	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 11. Mann-Whitney - Construct 2 - Item 3

With a *p-value* = 0.003 < α = 0.05, it was determined that the responses from the online group and face-to-face group are not distributed similarly.

4.3.3   Construct Three – Active Learning

The third construct focused on encouraging active learning through the Canvas Instructure LMS. The construct, Active Learning, contained two items. The items and response data are presented in Tables 19 and 20. Figures 12 and 13 show the results of the Mann-Whitney test for each item.

4.3.3.1.1 Construct 3 - Item 1 (Web links)

This course included interactive assignments and links to examples from the Web that directly involved me in the learning process.

Table 19 records all responses to the item addressing the students' opportunities to be involved with the learning process through Web Links within the Canvas Instructure LMS.

Table 19. SEOTE Survey Responses - Web Links

| | Item 1: Web Links | | | |
| | F2F | | Online | |
	Freq	%	Freq	%
Strongly Agree (1)	13	54.1	7	23.3
Agree (2)	10	41.7	20	66.7
Mildly Agree (3)	0	0	2	6.7
Mildly Disagree (4)	1	4.2	0	0
Disagree (5)	0	0	0	0
Strongly Disagree (6)	0	0	0	0
Not Applicable (NA)	0	0	1	3.3
No Response	0	0	0	0
Total	24	100	30	100

Figure 12 presents the results from the Mann-Whitney test on item regarding the interactive web links, comparing the responses of the online group and the face-to-face group.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Q13All is the same across categories of Q13Mod.	Independent-Samples Mann-Whitney U Test	.034	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 12. Mann-Whitney - Construct 3 - Item 1

With a *p-value* = 0.034 < α = 0.05, it was determined that the responses from the online group and face-to-face group are not distributed similarly.

4.3.3.1.2 Construct 3 - Item 2 (Responsibility)

The course allowed me to take responsibility for my own learning.

Table 20 records all responses to the item addressing the students' taking responsibility for their learning within the professional development course.

Table 20. SEOTE Survey Responses - Responsibility

| | Item 2: Responsibility | | | |
| | F2F | | Online | |
	Freq	%	Freq	%
Strongly Agree (1)	16	66.7	15	50
Agree (2)	7	29.1	15	50
Mildly Agree (3)	1	4.2	0	0
Mildly Disagree (4)	0	0	0	0
Disagree (5)	0	0	0	0
Strongly Disagree (6)	0	0	0	0
Not Applicable (NA)	0	0	0	0
No Response	0	0	0	0
Total	24	100	30	100

Figure 13 presents the results from the Mann-Whitney test on item regarding the learner

responsibility, comparing the responses of the online group and the face-to-face group.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Q14All is the same across categories of Q14Mod.	Independent-Samples Mann-Whitney U Test	.289	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 13. Mann-Whitney - Construct 3 - Item 2

With a *p-value* = 0.289 > α = 0.05, it was determined that the responses from the online group

and face-to-face group are distributed similarly.

4.3.4   Construct Four – Prompt Feedback

The fourth construct focused on prompt instructor feedback through the Canvas Instructure

LMS. The construct, Prompt Feedback, contained one item. The item and response data are

presented in Table 21. Figure 14 shows the results of the Mann-Whitney test for each item.

4.3.4.1.1   Construct 4 - Item 1 (Prompt Feedback)

My questions about course assignments were responded to promptly.

Table 21 records all responses to the item addressing instructor feedback in a prompt feedback

within the professional development course.

Table 21. SEOTE Survey Responses - Prompt Feedback

| | Item 1: Prompt Feedback | | | |
| | F2F | | Online | |
	Freq	%	Freq	%
Strongly Agree (1)	11	45.8	11	36.7
Agree (2)	12	50	14	46.7
Mildly Agree (3)	0	0	1	3.3
Mildly Disagree (4)	1	4.2	2	6.7
Disagree (5)	0	0	1	3.3
Strongly Disagree (6)	0	0	0	0
Not Applicable (NA)	0	0	1	3.3
No Response	0	0	0	0
Total	24	100	30	100

Figure 14 presents the results from the Mann-Whitney test on item regarding the instructor

feedback, comparing the responses of the online group and the face-to-face group.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Q15All is the same across categories of Q15Mod.	Independent-Samples Mann-Whitney U Test	.361	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 14. Mann-Whitney - Construct 4 - Item 1

With a *p-value* = 0.361 > α = 0.05, it was determined that the responses from the online group and face-to-face group are distributed similarly.

4.3.5   Construct Five – Time on Task

The fifth construct focused on the time spent working on the course elements. The construct, Time on Task, contained three items. The items and response data are presented in Tables 22 – 24. Figures 14 - 16 show the results of the Mann-Whitney test for each item.

4.3.5.1.1 Construct 5 - Item 1 (User Friendly):

The course was structured to be user friendly.

Table 22 records all responses to the item addressing instructor feedback in a prompt feedback within the professional development course.

Table 22. SEOTE Survey Responses - User Friendly

| | Item 1: User Friendly | | | |
| | F2F | | Online | |
	Freq	%	Freq	%
Strongly Agree (1)	11	45.8	6	20
Agree (2)	12	50	16	53.3
Mildly Agree (3)	0	0	4	13.3
Mildly Disagree (4)	1	4.2	2	6.7
Disagree (5)	0	0	2	6.7
Strongly Disagree (6)	0	0	0	0
Not Applicable (NA)	0	0	0	0
No Response	0	0	0	0
Total	24	100	30	100

Figure 15 presents the results from the Mann-Whitney test on item regarding whether or not the course structure was user friendly, comparing the responses of the online group and the face-to-face group.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Q16All is the same across categories of Q16Mod.	Independent-Samples Mann-Whitney U Test	.012	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 15. Mann-Whitney - Construct 5 - Item 1

With a *p-value* = 0.012 < α = 0.05, it was determined that the responses from the online group and face-to-face group are not distributed similarly.

4.3.5.1.2 Construct 5 - Item 2 (Efficient)

The course was designed to provide an efficient learning environment.

Table 23 records all responses to the item addressing if the professional development course was designed for an efficient learning environment.

Table 23. SEOTE Survey Responses - Efficient Learning

| | Item 2: Efficient | | | |
| | F2F | | Online | |
	Freq	%	Freq	%
Strongly Agree (1)	14	58.3	6	20
Agree (2)	9	37.5	16	53.4
Mildly Agree (3)	0	0	6	20
Mildly Disagree (4)	0	0	1	3.3
Disagree (5)	1	4.2	1	3.3
Strongly Disagree (6)	0	0	0	0
Not Applicable (NA)	0	0	0	0
No Response	0	0	0	0
Total	24	100	30	100

Figure 16 presents the results from the Mann-Whitney test on item regarding whether or not the course structure promoted efficient learning, comparing the responses of the online group and the face-to-face group.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Q17All is the same across categories of Q17Mod.	Independent-Samples Mann-Whitney U Test	.002	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 16. Mann-Whitney - Construct 5 - Item 2

With a *p-value* = 0.002 < α = 0.05, it was determined that the responses from the online group and face-to-face group are not distributed similarly.

4.3.5.1.3 Construct 5 - Item 3 (Variety)

The course allowed me to complete assignments across a variety of learning

environments.

Table 24 records all responses to the item addressing if the professional development course was

designed with opportunities for a variety of learning environments.

Table 24. SEOTE Survey Responses - Variety

	Item 3: Variety			
	F2F		Online	
	Freq	%	Freq	%
Strongly Agree (1)	11	45.8	7	23.3
Agree (2)	10	41.7	19	63.4
Mildly Agree (3)	2	8.3	4	13.3
Mildly Disagree (4)	0	0	0	0
Disagree (5)	1	4.2	0	0
Strongly Disagree (6)	0	0	0	0
Not Applicable (NA)	0	0	0	0
No Response	0	0	0	0
Total	24	100	30	100

Figure 17 presents the results from the Mann-Whitney test on item regarding whether or not the

course structure promoted a variety of learning environments, comparing the responses of the

online group and the face-to-face group.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Q18All is the same across categories of Q18Mod.	Independent-Samples Mann-Whitney U Test	.172	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 17. Mann-Whitney - Construct 5 - Item 3

With a *p-value* = 0.172 > α = 0.05, it was determined that the responses from the online group

and face-to-face group are distributed similarly.

4.3.6 Construct Six – High Expectations

The sixth construct focused on the expectations associated with the course elements. The

construct, High Expectations, contained two items. The items and response data are presented in

Tables 25 and 26. Figures 17 and 18 show the results of the Mann-Whitney test for each item.

4.3.6.1.1 Construct 6 - Item 1 (Clear Communication)

> *This course used examples that clearly communicated expectations for completing course*
> *assignments.*

Table 25 records all responses to the item addressing if there was clear communication within

the professional development course.

Table 25. SEOTE Survey Responses - Clear Communication

	Item 1: Clear Communication			
	F2F		Online	
	Freq	%	Freq	%
Strongly Agree (1)	13	54.1	8	26.7
Agree (2)	8	33.3	16	53.3
Mildly Agree (3)	1	4.2	4	13.4
Mildly Disagree (4)	0	0	1	3.3
Disagree (5)	1	4.2	0	0
Strongly Disagree (6)	0	0	0	0
Not Applicable (NA)	1	4.2	0	0
No Response	0	0	1	3.3
Total	24	100	30	100

Figure 18 presents the results from the Mann-Whitney test on item regarding whether or not the

course contains clear communication, comparing the responses of the online group and the face-

to-face group.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Q19All is the same across categories of Q19Mod.	Independent-Samples Mann-Whitney U Test	.047	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 18. Mann-Whitney - Construct 6 - Item 1

With a *p-value* = 0.047 < α = 0.05, it was determined that the responses from the online group and face-to-face group are not distributed similarly.

4.3.6.1.2 Construct 6 - Item 2 (Examples)

This course provided good examples and links to other examples published on the Web that helped to explain concepts and skills.

Table 26 records all responses to the item addressing if there good examples provided within the professional development course.

Table 26. SEOTE Survey Responses - Examples

	Item 2: Examples			
	F2F		Online	
	Freq	%	Freq	%
Strongly Agree (1)	13	54.1	6	20
Agree (2)	10	41.7	20	66.7
Mildly Agree (3)	1	4.2	3	10
Mildly Disagree (4)	0	0	0	0
Disagree (5)	0	0	0	0
Strongly Disagree (6)	0	0	0	0
Not Applicable (NA)	0	0	0	0
No Response	0	0	1	3.3
Total	24	100	30	100

Figure 19 presents the results from the Mann-Whitney test on item regarding whether or not the course contains clear communication, comparing the responses of the online group and the face-to-face group.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Q20All is the same across categories of Q20Mod.	Independent-Samples Mann-Whitney U Test	.014	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 19. Mann-Whitney - Construct 6 - Item 2

With a *p-value* = 0.014 < α = 0.05, it was determined that the responses from the online group and face-to-face group are not distributed similarly.

4.3.7   Construct Seven – Diverse Talents and Ways of Learning

The seventh construct focused on the various ways of learning. The construct, Diverse Talents and Ways of Learning, contained three items. The items and response data are presented in Tables 27 - 29. Figures 19 - 21 show the results of the Mann-Whitney test for each item.

4.3.7.1.1 Item 1 (Respectful)

The instructor was respectful of students' ideas and views.

Table 27 records all responses to the item addressing if students' views and ideas were respected by the instructor in the professional development course.

Table 27. SEOTE Survey Responses - Respectful

| | Item 1: Respectful | | | |
| | F2F | | Online | |
	Freq	%	Freq	%
Strongly Agree (1)	16	66.7	8	26.7
Agree (2)	7	29.1	16	53.3
Mildly Agree (3)	0	0	2	6.7
Mildly Disagree (4)	0	0	0	0
Disagree (5)	0	0	0	0
Strongly Disagree (6)	0	0	0	0
Not Applicable (NA)	1	4.2	3	10
No Response	0	0	1	3.3
Total	24	100	30	100

Figure 20 presents the results from the Mann-Whitney test on item regarding whether or not the

participants felt the instructor was respectful of their views, comparing the responses of the

online group and the face-to-face group.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Q21All is the same across categories of Q21Mod.	Independent-Samples Mann-Whitney U Test	.005	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 20. Mann-Whitney - Construct 7 - Item 1

With a *p-value* = 0.005 < α = 0.05, it was determined that the responses from the online group

and face-to-face group are not distributed similarly.

4.3.7.1.2 Item 2 (Interference)

The course was designed so that technology would minimally interfere with learning.

Table 28 records all responses to the item addressing if technology interferes with learning in the

professional development course.

Table 28. SEOTE Survey Responses - Interference

	Item 2: Interference			
	F2F		Online	
	Freq	%	Freq	%
Strongly Agree (1)	9	37.5	9	30
Agree (2)	11	45.8	15	50
Mildly Agree (3)	3	12.5	1	3.3
Mildly Disagree (4)	0	0	0	0
Disagree (5)	1	4.2	2	6.7
Strongly Disagree (6)	0	0	0	0
Not Applicable (NA)	0	0	2	6.7
No Response	0	0	1	3.3
Total	24	100	30	100

Figure 21 presents the results from the Mann-Whitney test on item regarding whether or not the

participants felt the technology interfered with the learning process, comparing the responses of

the online group and the face-to-face group.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Q22All is the same across categories of Q22Mod.	Independent-Samples Mann-Whitney U Test	.852	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 21. Mann-Whitney - Construct 7 - Item 2

With a *p-value* = 0.852 > α = 0.05, it was determined that the responses from the online group

and face-to-face group are distributed similarly.

4.3.7.1.3   Item 3 (Flexibility)

Flexibility was permitted when completing course assignments.

Table 29 records all responses to the item addressing if students viewed the professional

development course as having flexibility.

Table 29. SEOTE Survey Responses - Flexibility

| | Item 3: Flexibility | | | |
| | F2F | | Online | |
	Freq	%	Freq	%
Strongly Agree (1)	11	45.8	15	50
Agree (2)	8	33.3	12	40
Mildly Agree (3)	3	12.5	0	0
Mildly Disagree (4)	0	0	0	0
Disagree (5)	0	0	1	3.3
Strongly Disagree (6)	0	0	0	0
Not Applicable (NA)	1	4.2	0	0
No Response	1	4.2	2	6.7
Total	24	100	30	100

Figure 22 presents the results from the Mann-Whitney test on item regarding whether or not the

participants there was flexibility within the course, comparing the responses of the online group

and the face-to-face group.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Q23All is the same across categories of Q23Mod.	Independent-Samples Mann-Whitney U Test	.433	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 22. Mann-Whitney-Construct 7 - Item 3

With a *p-value* = 0.433 < α = 0.05, it was determined that the responses from the online group and face-to-face group are distributed similarly.

This chapter presented the data collected for each of the three research questions of this study. Statistical analyses were presented in tabular and graphical form to display the results of the face-to-face and online groups of participants.

CHAPTER 5.   DISCUSSION AND CONCLUSIONS

This study considered the effectiveness of professional development comparing a face-to-face modality with an online modality. While previous studies focused mainly on teacher perceptions, reported through qualitative surveys, this study sought to measure quantitative achievement through the use of established assessment tools related to subject-matter content. Participants self-selected the modality for instruction and completed a series of activities to measure subject-matter knowledge for the LOGM 127 (Introduction to Logistics) course, as well as material assessed through the Manufacturing Skills Standards Council Certified Logistics Associate exam. While chapter four presented the data gathered through this mixed-methods, quasi-experimental research, chapter five discusses implications of those results and opportunities for further research.

5.1   Research Question One

Research question one addressed the effectiveness of online professional development compared to face-to-face professional development for preparing teachers to teach the LOGM 127 "Introduction to Logistics" content. This was assessed by comparing the differences between the posttest score and the pretest score on the LOGM 127 end-of-course assessment exam for each group. The one-way AONVA resulted a *p-value* = 0.827, indicating that the means of the two groups were not significantly different. Based on this result, the data suggests that online professional development is as effective as face-to-face professional development for preparing to teach the LOGM 127 Introduction to Logistics course.

Reliability for the exam was calculated from the posttest of the participants, which yielded an alpha of 0.8553. This alpha is considered acceptable for establishing reliability, as it is

higher than the recommended level of 0.80 (Carmines & Zeller, 1979, p.51). As discussed

previously, limitations on generalizability exist due to the narrow population and content area.

This study focused on supply chain management and logistics content with teachers who were

likely to teach this course content in the near future. As established in the literature, teachers

desire to have professional development specific to their areas of instruction. They value this

type of training greater than training on broad topics (Casale, 2011). This supports the value of

providing teachers with professional development related to specific course content, as seen in

this study.

5.2   Research Question Two

Research question two addressed the effectiveness of online professional development

compared to face-to-face professional development for preparing teachers to take the MSSC

CLA certification exam. MSSC CLA exam scores were assessed by comparing the scores of

each group. A one-way ANOVA was performed which yielded a *p-value* = 0.421, indicating no

statistically significant difference between the means of the two groups. From this result, the data

suggests that the online professional development is as effective as the face-to-face professional

development when preparing instructors for the MSSC CLA certification exam. Due to the

proprietary nature of the exam, reliability for this exam was unavailable.

As with this first research question, the participants of this study were those who were

likely to teach MSSC CLA content in the near future. The preparation for this certification exam

not only provides a necessary credential for being qualified for instruction, but also provided

experience with the same certification exam that will be required of their future students taking

LOGM 127 (Introduction to Logistics). As LOGM 127 continues to increase in offerings

throughout the state of Indiana at both the high school and college level, there will continue to be

a need for training new instructors for this certification, making the results of this study directly applicable to future needs in teacher training within the State of Indiana.

5.3   Research Question Three

Research question three addressed the teacher's perceived effectiveness of the course, using the SEOTE survey instrument. Mann-Whitney tests were performed on each item to determine if the online group and face-to-face group were distributed similarly. Those items that were significantly different are noted with an asterisk. Significant results are discussed in greater detail with practical implications and applications in section 5.6.

Table 30. Summary of Research Question Three

Item	Construct		Agreement Freq.		Mann-Whitney *p-value*
	Group	Item	F2F	Online	
1 - 1	Student Faculty Contact	Instructor Communication	23	29	0.023*
1 - 2	Student Faculty Contact	Enthusiasm	19	27	0.283
1 - 3	Student Faculty Contact	Accessible	21	27	0.253
1 - 4	Student Faculty Contact	Instructor Contact	23	24	0.092
2 - 1	Cooperation Among Students	Student Discussion	22	26	0.007*
2 - 2	Cooperation Among Students	Student Interaction	23	27	0.031*
2 - 3	Cooperation Among Students	Interactive Activities	23	25	0.003*
3 - 1	Active Learning	Web Links	23	29	0.034*
3 - 2	Active Learning	Responsibility	24	30	0.289
4 - 1	Prompt Feedback	Prompt Feedback	23	25	0.361
5 - 1	Time on Task	User Friendly	23	26	0.012*
5 - 2	Time on Task	Efficient	23	28	0.002*
5 - 3	Time on Task	Variety	23	30	0.172
6 - 1	High Expectations	Clear Communication	22	28	0.047*
6 - 2	High Expectations	Examples	24	29	0.014
7 - 1	Diverse Talents	Respectful	23	26	0.005*
7 - 2	Diverse Talents	Interference	23	25	0.852
7 - 3	Diverse Talents	Flexibility	22	27	0.433

* indicates statistical significance (*p-value* < α = 0.05)

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5.3.1 Construct One – Student Faculty Contact

Construct One focused on the communication between the faculty and the student. Of the four items regarding communication, one item was not supported as having similar distributions between the online and face-to-face group, as determined by the Mann-Whitney test. Construct 1 – Item 1 "The instructor communicated effectively" had a *p-value* = .023. The open-ended responses addressing communication included:

- Face-to-face: "*The only reason why I wrote mildly disagree with the instructor liked teaching an online class is that she stated that she is much more comfortable with the face-to-face format versus online format.*"

- Online: "*I needed more detailed instructions and I never received my books even though I submitted my address and the required information needed.*"

The response indicates that at least one participant did not feel that there was effective communication and that there could have been some perceived bias about online instruction.

5.3.2 Construct Two – Cooperation Among Students

Construct Two had three items related to student interaction. The Mann-Whitney test for each of these three items resulted in a *p-value* < α = 0.05, establishing that the online group and face-to-face group are not similarly distributed. The face-to-face participants worked together during their face-to-face workshop and completed numerous activities in small groups and as a class. The course was specifically designed to be asynchronous for online participants, meaning that a student did not have any specific activities that required interaction with other students. Activities that promoted interaction included discussion boards, video chats and webinars. These activities were available to all participants but were optional. Video chats and webinars were recorded and posted to be viewed at a later time. While the literature presents asynchronous

instruction as helpful for accommodating flexible schedules (Carr, 2016; Schoenbach et al., 2016), these survey results support that asynchronous instruction could reduce interaction amongst students, especially when collaborative activities are optional for participants.

5.3.3   Construct Three – Active Learning

Construct Three addressed active learning within the Canvas Instructure LMS. The first item of this construct; "This course included interactive activities and links to examples from the Web that directly involved me in the learning process" had a *p-value* = 0.034. A face-to-face participant stated:

- *"There simply was no direction to the course, just a bunch of links and quasi activities"*.

The statement suggests that at least one participant did not find the provided web links helpful to their learning process. The second item for this construct rated the participants perceived responsibility for their learning and showed similar responses for both modalities.

5.3.4   Construct Four – Prompt Feedback

Construct four had one item that stated, "My questions about course activities were responded to promptly." For this construct, the responses from the online group and the face-to-face group are distributed similarly. No additional comments were received regarding this construct in the open-ended response section. While face-to-face participants had in-person access to the instructor during the workshop, all participants had access to the instructor via messaging functions within the Canvas Instructure LMS, email and phone.

5.3.5 Construct 5 – Time on Task

Three items were included in construct 5. The first two items addressed course structure and design. Item 1 read "The course was structured to be user friendly" and had a *p-value* = 0.012. Item 2 stated "The course was designed to provide an efficient learning environment" and had a *p-value* = 0.002. For both of these items, the distribution of responses from the online group and the face-to-face group are different. Additionally, open-ended responses from participants addressed course design. Online participants wrote:

- *"The structure of the course in Canvas was incredibly difficult to understand. It was not logical"*

- *"I needed more detailed instructions"*

  A face-to-face participant responded:

- *"There simply was no direction to the course, just a bunch of links and quasi activities"*

These comments suggest confusion within the course navigation and the presentation of content. The face-to-face group did have a portion of the workshop dedicated to orienting participants to the online course content, structure, design and intent for each activity. This same orientation was provided through a webinar to all participants, but only10 individuals attended the webinar in real-time. It is not known if this webinar was accessed at a later time by other individuals.

The third item of this construct read "The course allowed me to complete activities across a variety of learning environments" and the Mann-Whitney test supports that the online group and the face-to-face group responded in similar ways.

5.3.6 Construct 6 – High Expectations

The two items in this construct read "This course used examples that clearly communicated expectations for completing course activities" and "This course provided good examples and links to other examples published on the Web that helped to explain concepts and skills". Both items had *p-values* < α = 0.050, showing that the online group and face-to-face group responses are not distributed similarly. These items are similar to those addressed in construct 5, with the open-ended responses being applicable to this area as well. This would seem to support the difference in comfort with course navigation between the face-to-face group and the online group.

5.3.7 Construct 7 – Diverse Talents and Ways of Learning

Two of the three items associated with this construct had *p-values* > α = 0.050, showing that the online group and face-to-face group responses are distributed similarly. One item did show a difference between the two groups. The item read, "The instructor was respectful of students' ideas and views" and the *p-value* = 0.005. It is important to note that for this item, there were no negative responses from either groups. However, the online group had over 13% respondents mark this item "Not Applicable" or left the item blank, compared to only 4% face-to-face participants marking the item "Not Applicable." The difference in frequency of marking "Not Applicable" between the two groups may explain why there was a significant difference measured by the Mann Whitney test.

5.4   Study Limitations

While the results point to the effectiveness of online professional development being comparable to face-to-face professional development, there are several limitations to this study that limit broader generalization of the results.

First, the sample size was only 54, compared to the population of instructors who either teach business dual credit courses in Indiana high schools or teach business courses at Ivy Tech Community College, which was estimated to be 540 individuals. Participation was open to the entire population, but only approximately 10% chose to take part in the professional development experience. No data were collected from the individuals who did not register for the training, therefore it is impossible to determine the factors that may have influenced individuals' decisions to not participate.

As discussed in chapter 2, the majority of studies examining online professional development relied on voluntary participation. As such, participants who volunteered for the online modality may have a positive bias toward online learning compared. If random assignments had been given, there would have been the potential of having individuals in the online modality who would have preferred the face-to-face modality. However, many previous studies comparing online and face-to-face coursework use samples that are self-selected, as enrollment in online courses has been voluntary (Shea & Bidjerano, 2014).

Online professional development has been perceived to be effective for those participants who were given the choice to participate in such studies (Dash et al., 2012; Desimone, 2009; Klienman & Treacy, 2002; Whitehouse et al., 2002). The results of this study are consistent with previous work in this area, while offering a quantitative assessment in additional to qualitative assessment and analysis techniques.

Finally, the study was intentionally delimited to a narrow field of content within the business and technology curriculum. Both LOGM 127 and the MSSC CLA certification exam are considered to be introductory levels of competency with logistics content. Additionally, instructors in this area may differ from instructors of content with broader application, such as math or reading. However, as the focus of this study was for technical educators, the course content was appropriate for this study, although it does limit a broader generalization of the results.

5.5   Additional Insights

5.5.1   Time Using Canvas Instructure

One factor of interest was the amount of time spent using the Canvas Instructure online Learning Management System. Both face-to-face participants and online participants had unlimited access to course content throughout the duration of the study. When the two groups were compared to one another, it was observed that the average number of minutes spent online was similar, regardless of the chosen modality. While online learners averaged 630 minutes (10.5 hours) the face-to-face learners averaged 486 minutes (8.1 hours). Both groups had a wide range in the amount of time spent on Canvas Instructure, as seen in Table 31.

Table 31. Minutes using Canvas Instructure LMS

Modality	Face-to-Face	Online
Average (Minutes)	486	630
Maximum (Minutes)	2006	2829
Minimum (Minutes)	31	55
Range (Minutes)	1975	2774

While it was expected that online only participants would spend more time using the Canvas Instructure LMS, the wide range of times was not expected. It was also unexpected to see a large range of times for the face-to-face participants. The researcher tested for normality by conducting a normal probability plot and a Anderson Darling test for normality, which showed that the samples were not normal. Therefore, the researcher used a nonparametric comparison of means to see if the samples were comparable. A Mann-Whitney test was conducted with the results seen in Figure 23.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of TimeAll is the same across categories of TimeMod.	Independent-Samples Mann-Whitney U Test	.174	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 23. Mann-Whitney test for Minutes Spent Using Canvas Instructure LMS

Since the *p-value* = 0.174 > α =0.05, the tests indicates that the amount of time for the two groups are comparable, even though one group only had access to the online materials, while the other group attended a face-to-face workshop in addition to having access to the materials.

With this information, one could question how the face-to-face participants would have done in the study had they not been given access to the materials. When evaluating the time spent with the online learning materials and the responses to the survey regarding the learning experience, it appears that even those who chose the face-to-face modality received benefit from the online materials and appreciated the resources provided.

5.5.2   MSSC CLA Certification Exam Pass Rate

While an ANVOVA procedure indicated that there was no statistically significant difference between the mean scores of the two groups, it is important to note that all but three individuals passed the MSSC CLA certification exam. That equals a pass rate of 94.4%, which is higher than the national average pass rate of less than 75% (MSSC, 2016). Therefore, when evaluating this training opportunity as effective preparation for completing the MSSC CLA certification exam (as discussed in research question two), one could conclude that this professional development successfully prepared teachers for the exam, regardless of modality.

The success rate is important to note, as supporters of online professional development often point to the low cost of implementation, the flexibility of deployment and the increased access for teachers as being primary reasons to pursue online professional development.

5.6   Implications for Policy and Practice

Data gathered from this study supports previous work done in the field of expanding online professional development for educators. Quantitative measures for content knowledge, both related to LOGM 127 (Introduction to Logistics) and to the MSSC CLA Certification exam demonstrated that the two groups of educators did not differ significantly regardless of modality.

However, the mortality of rate of online participants for this study is similar to the mortality rate reported in other studies regarding online education (Shea & Bidjerano, 2014; Xu & Jaggers, 2013). With an online mortality rate of 44%, it is questionable how effective professional development would be if the online option was the only option available to instructors. Sahr (2016) cautions against using results from voluntary participation to support mandatory online professional development efforts. As opportunities for online professional development increase, best practices for implementation should be used to help reduce mortality rates.

One best practice documented in literature is the use of orientation sessions for online learners. While not all individuals may feel comfortable taking an online course, best practices incorporating orientation sessions have been documented as increasing student motivation, persistence and achievement (Beckford, 2015; Jones, 2013; Robichaud, 2016). The results of the survey administered in this study support previous research. Mann-Whitney tests showed differences in the distributions of the online and face-to-face group responses primarily in areas related to course organization, navigation and interaction. Open-ended responses also showed frustration of several participants regarding the course instruction, direction and structure. Orientation to the course seemed to be helpful to participants, as they were more positive about course navigation and structure. As participants in this study accessed the online content similarly, regardless of chosen modality, future studies offering professional development solely online could be effective in training teachers, even if those teachers do not prefer online instruction. Education administrators that are considering mandating professional development that is solely online should consider requiring orientation activities to reduce mortality and decrease potential frustration of participants.

While not generalizable beyond the intended population, the results of this study support previous studies linking successful professional development with meaningful content. Previous literature has shown teachers to be highly motivated students, when the professional development supports necessary skills for success in the classroom (Edney, 2010). However, even highly motivated learners are in need of support when completing an online course. Teachers must be presented with quality instruction for the professional development to be successful, regardless of modality (Desimone, 2009). Previous studies regarding student success and persistence in online coursework has determined course design and instructor involvement to be critical factors in student success (Xu & Jaggers, 2013).

The design of the course used in this study was based on several documented best practices in professional development, including: being designed to address specific learning goals; provides opportunities for teachers to build their content and pedagogical content knowledge and reflect on practice; being research based and engages teachers in the learning approaches they will use with their students; provides opportunities for teachers to collaborate with colleagues and other experts to improve their practice (Loucks-Horsley et al., 1998). While specific concerns were stated by several participants, general positive feedback was also received in the open-ended response area of the survey from both online and face-to-face participants. These comments include:

- *"I learned a lot!"*
- *"I think it is an excellent course"*
- *"Enjoyed the course and look forward to passing the exam"*
- *"Well done"*
- *"Loved it!"*

- *"The course was excellent"*

- *"The instructor does an excellent job with this learning experience"*

- *"The instructor was able to make the course interesting and easy to follow"*

The open-eneded responses, in conjunction with the exam pass rate, demonstrate that the course design established in light of previous studies regarding professional development and learning theory are best practices that should be used in professional development, regardless of modality or subject matter. As such, this study supports the larger body of knowledge by building on previous learning theory and demonstrating the effectiveness of course design with quantitative and qualitative metrics.

5.7 Implications for Future Research

This research supported previous qualitative studies of perceived effectiveness of online professional development. It also made use of previously established learning theory for instructional design of professional development for educators. With quantitative and qualitative findings that support online professional development being as effective as face-to-face professional development, future research can integrate these findings with new areas of study.

As stated above, orientation sessions have been shown to be effective in reducing mortality of online learning. A replication of this study with orientation activities as a required component could help provide further insight on the use of orientation in online coursework. Several measures could be integrated to better understand the participants expectations and preexisting attitudes towards online professional development. Gümüşoğlu and Akay (2017) have used previous work in the Unified Theory of Acceptance and Use of Technology (UTAUT) model when looking to support teacher education and adoption of technology in the classroom.

The UTAUT model addresses effort expectancy, social behavior, performance expectancy and facilitating conditions, which could help explain hesitancy of teachers towards online professional development and their experience with the online modality. Incorporating the UTAUT model in future professional development research could provide valuable information for shaping future practices in online professional development.

True randomization of participants between online and face-to-face modalities could also provide insight into the effectiveness of online professional development, without concerns of pre-existing bias, as mentioned above. A study in which modality was assigned and attitudes towards online professional development were surveyed before and after the training occurred could assist in the development and implementation of future online experiences. This need is critical as administrators considered wider use of online professional development to meet federal regulations mandating professional development activities for k-12 teachers in the United States (Estepp, Thorn, Roberts, & Dyer, 2014).

The high success rate for passing the MSSC CLA certification exam demonstrated both the online modality and the face-to-face modality as being effective for preparation for a national certification. As the US Department of Education continues to direct funding towards industry-oriented credentials into secondary and post-secondary education (Carl D. Perkins Career and Technical Education Act, 2006), this course could serve as a model for future online professional development for other industry certifications. The Indiana Department of Education recognizes 134 industry credentials as part of the Career and Technical Education pathway, with implementation of these credentials increasing each year (IDOE, 2018-A). Technical educators will continue to need professional development to prepare them for new and changing industry-base credentials integrated into K-12 curriculum. Therefore, future work using this study as a

model for other types of industry-based credentials would be helpful when planning to meet the needs of CTE professional development in years to come.

5.8   Conclusions

This study was intentionally designed to address professional development needs in technical educators in the field of supply chain management and logistics. It was found that there was no difference between the face-to-face group and the online group in effectiveness for learning the LOGM 127 (Introduction to Logistics) course content or preparation for the MSSC CLA certification exam. A survey of participant perceptions recorded differences in perceptions of course structure, supporting activities and communication with both the instructor and their peers. However, qualitative reviews from both online and face-to-face participants reported the course as successful and effective. The high pass rate for the MSSC CLA certification exam also demonstrates the success of the course.

As previous studies regarding online professional development addressed a wide variety of disciplines, the consistency demonstrated by this study further supports the use of online professional development as an effective means for supporting teachers, regardless of subject matter content. Specifically, this research supports the use of online professional development on a voluntary basis with technical educators and can help to reduce the costs and time associated with attending face-to-face workshops. Future research addressing online mortality rates, online orientation, technology adoption and other industry credentials would benefit the overall body of knowledge regarding professional development and online course best practices.

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APPENDIX A. IRB EXEMPTION STATUS

PURDUE
UNIVERSITY

HUMAN RESEARCH PROTECTION PROGRAM
INSTITUTIONAL REVIEW BOARDS

To:	ELY, SUSAN J
From:	DICLEMENTI, JEANNIE D, Chair Social Science IRB
Date:	02/20/2018
Committee Action:(1)	Determined Exempt, Category (1)
IRB Action Date:	02 / 20 / 2018
IRB Protocol #:	1801020099
Study Title:	Effectiveness of Online Professional Development for Technical Educators

The Institutional Review Board (IRB) has reviewed the above-referenced study application and has determined that it meets the criteria for exemption under 45 CFR 46.101(b).

Before making changes to the study procedures, please submit an Amendment to ensure that the regulatory status of the study has not changed. Changes in key research personnel should also be submitted to the IRB through an amendment.

General

- To recruit from Purdue University classrooms, the instructor and all others associated with conduct of the course (e.g., teaching assistants) must not be present during announcement of the research opportunity or any recruitment activity. This may be accomplished by announcing, in advance, that class will either start later than usual or end earlier than usual so this activity may occur. It should be emphasized that attendance at the announcement and recruitment are voluntary and the student's attendance and enrollment decision will not be shared with those administering the course.
- If students earn extra credit towards their course grade through participation in a research project conducted by someone other than the course instructor(s), such as in the example above, the students participation should only be shared with the course instructor(s) at the end of the semester. Additionally, instructors who allow extra credit to be earned through participation in research must also provide an opportunity for students to earn comparable extra credit through a non-research activity requiring an amount of time and effort comparable to the research option.
- When conducting human subjects research at a non-Purdue college/university, investigators are urged to contact that institution's IRB to determine requirements for conducting research at that institution.
- When human subjects research will be conducted in schools or places of business, investigators must obtain written permission from an appropriate authority within the organization. If the written permission was not submitted with the study application at the time of IRB review (e.g., the school would not issue the letter without proof of IRB approval, etc.), the investigator must submit the written permission to the IRB prior to engaging in the research activities (e.g., recruitment, study procedures, etc.). Submit this documentation as an FYI through Coeus. This is an institutional requirement.

Categories 2 and 3
- Surveys and questionnaires should indicate
  - only participants 18 years of age and over are eligible to participate in the research; and
  - that participation is voluntary; and
  - that any questions may be skipped; and
  - include the investigator's name and contact information.
- Investigators should explain to participants the amount of time required to participate. Additionally, they should explain to participants how confidentiality will be maintained or if it will not be maintained.
- When conducting focus group research, investigators cannot guarantee that all participants in the focus group will maintain the confidentiality of other group participants. The investigator should make participants aware of this potential for breach of confidentiality.

Category 6
- Surveys and data collection instruments should note that participation is voluntary.
- Surveys and data collection instruments should note that participants may skip any questions.
- When taste testing foods which are highly allergenic (e.g., peanuts, milk, etc.) investigators should disclose the possibility of a reaction to potential subjects.

You are required to retain a copy of this letter for your records. We appreciate your commitment towards ensuring the ethical conduct of human subjects research and wish you luck with your study.

APPENDIX B. GOOGLE REGISTRATION FORM

Event registration

2018 Supply Chain and Logistics Teacher Training Workshop

* Required

1. **Email address** *

_____

2. **Which session will you attend?** *
   Mark only one oval.

   ◯ ONLINE - Asynchronous workshop - February 5 - February 23rd, 2018

   ◯ Face to Face workshop at Ivy Tech Community College Indianapolis Campus - February 17 and 18, 2018

3. **Name** *

_____

4. **Email** *

_____

5. **Organization** *

_____

6. **Are you currently teaching LOGM 127?** *
   Mark only one oval.

   ◯ Yes

   ◯ No

7. **Are you currently teaching dual credit courses?** *
   Mark only one oval.

   ◯ Yes

   ◯ No

Additional Notes for Participants

Both the face-to-face version of the course and the online version are estimated at 16 hours. All participants will receive a certificate of completion stating they have earned 16 hours of professional development.
All participants will receive a $500.00 stipend upon completion of the course. All participants will have the registration and certification exam costs covered for the MSSC CLA exam. All participants will receive class sets of course materials.

The online session is asynchronous and completed independently. While participants have access to the materials for the four week duration, they may finish early if they wish. A course facilitator will be available for any questions during the online training.

The face-to-face participants will be reimbursed for travel expenses including: hotel for 1 night, mileage and per diem for 2 days.

Powered by

Google Forms

APPENDIX C. INVITATION TO PARTICIPATE

BUSINESS AND SUPPLY CHAIN MANAGEMENT CERTIFICATION FOR DUAL CREDIT AND IVY TECH INSTRUCTORS

FACE TO FACE OPTION
FEBRUARY 17 &18

ONLINE OPTION
FEBRUARY 5 – FEBRUARY 23

Both the face-to-face version of the course and the online version are estimated at 16 hours. All participants will receive a certificate of completion stating they have earned 16 hours of professional development. All participants will receive a $500.00 stipend upon completion of the course. All participants will have the registration and certification exam costs covered for the MSSC CLA exam. All participants will receive class sets of course materials. The online session is asynchronous and completed independently. While participants have access to the materials for the four week duration, they may finish early if they wish. The face-to-face participants will be reimbursed for travel expenses including: hotel for 1 night, mileage and per diem for 2 days.

TO REGISTER:

https://goo.gl/forms/t3uq3gSVGfglA1Hu1

Free Registration

———

Receive a Certificate of 16 hours Professional Development

———

No Certification Exam Fee

———

Receive a $500 Stipend

———

Reimbursed for travel expenses

IVY TECH COMMUNITY COLLEGE
50 West Fall Creek Parkway North Drive,
Indianapolis 46208

Room 508

8:00 am- 5:00pm

APPENDIX D. PARTICIPATION FORM

Crossroad Logistics
Leveraging Indiana's Role as the Crossroads of America

Professional Development Participation Notification

Funding for all activities and associated costs have been paid for using NSF ATE grant awards 1304619 and 1304520, "Crossroad Logistics", a joint research project between Ivy Tech Community College and Purdue University. Grant activities were subject to Purdue University's Institutional Review Board and were granted exempt status. As required by federal grant reporting standards and dissemination efforts, data gathered from professional development sessions will be reported and potentially published. However, all data gathered will remain anonymous, with all personal identifiers being removed and destroyed prior to data analysis and publication. Potential data reviewed could include:

- Non-identifiable demographic information, such as:
    - Years teaching
    - Industry experience
    - Anticipated instructional setting
- Statistical analysis of diagnostic assessment (pre and post)
- Statistical analysis of survey results
- Non-identifiable analysis of open ended survey questions
- Statistical analysis of MSSC CLA certification pass rates

As a participant in this professional development you are expect to complete the following activities:

- Completion of diagnostic assessments (pre and post)
- Completion of anonymous survey upon training completion
- Completion of all training activities included in the workshop
- Completion of the MSSC CLA certification exams within 2 months of training completion*

As a participant in this professional development, you will receive the following compensation:

- Classroom supplies for activities demonstrated online shipped to the address of your choice
- Registration and assessment costs for the MSSC CLA exam
- $500.00 stipend

By signing below, you are affirming that you understand participant expectations, compensation and use of non-identifiable data collected through the process.

_____   _____   _____

Printed Name   Signature   Date

IVY TECH COMMUNITY COLLEGE   National Science Foundation WHERE DISCOVERIES BEGIN   PURDUE UNIVERSITY

AWARDS 1304619 AND 1304520

Crossroad Logistics
Leveraging Indiana's Role as the Crossroads of America

Professional Development Participation Notification

Funding for all activities and associated costs have been paid for using NSF ATE grant awards 1304619 and 1304520, "Crossroad Logistics", a joint research project between Ivy Tech Community College and Purdue University. Grant activities were subject to Purdue University's Institutional Review Board and were granted exempt status. As required by federal grant reporting standards and dissemination efforts, data gathered from professional development sessions will be reported and potentially published. However, all data gathered will remain anonymous, with all personal identifiers being removed and destroyed prior to data analysis and publication. Potential data reviewed could include:

- Non-identifiable demographic information, such as:
  o Years teaching
  o Industry experience
  o Anticipated instructional setting
- Statistical analysis of diagnostic assessment (pre and post)
- Statistical analysis of survey results
- Non-identifiable analysis of open ended survey questions
- Statistical analysis of MSSC CLA certification pass rates

As a participant in this professional development you are expect to complete the following activities:

- Completion of diagnostic assessments (pre and post)
- Completion of anonymous survey upon training completion
- Completion of all training activities included in the workshop
- Completion of the MSSC CLA certification exams within 2 months of training completion*

As a participant in this professional development, you will receive the following compensation:

- Travel reimbursement for hotel and mileage, as well as per diem at the current Ivy Tech Community College rate
- Classroom supplies for activities demonstrated during workshop
- Registration and assessment costs for the MSSC CLA exam
- $500.00 stipend

By signing below, you are affirming that you understand participant expectations, compensation and use of non-identifiable data collected through the process.

_____   _____   _____

Printed Name   Signature   Date

APPENDIX E. QUALTRICS OPEN-ENDED RESPONSES

Default Report

NSF ATE Professional Development Survey
October 24, 2018 5:37 AM MDT

Q24 - Please add any additional comments about the course below.

Please add any additional comments about the course below.

I am late in completing everything, but this was due to my issues-not the course or instructor.

I needed more detailed instructions and I never received my books even though I submitted my address and the required information needed.

Loved it!!

The structure of the course in Canvas was incredibly difficult to understand. It was not logical.

None. the course was excellent.

Susan does an excellent job with this learning experience.

well done

The only reason why I wrote mildly disagree with the instructor liked teaching an online class is that she stated that she is much more comfortable with the face-to-face format versus online format.

Susan did such a good job with this course. She was able to make the course interesting and easy to follow. I am glad I attended.

Enjoyed the course and look forward to passing the exam.

Susan was fantastic!

Susan was an outstanding instructor. I learned a lot!

There simply was no direction to the course, just a bunch of links and quasi activities.

I think it is an excellent course

Showing records 1 - 14 of 14

End of Report

VITA

Susan J. Ely

Purdue University, Polytechnic Institute West Lafayette, Indiana

> *Ph.D.* Technology Leadership and Innovation, Status: December 2018 Candidate
>
> > *Dissertation***: "***Effectiveness of online professional development for technical educators"*
> > *Advisor:* Dr. Mathias Sutton

Purdue University, College of Technology West Lafayette, Indiana

> *M.S.*, Industrial Technology, December 2010
> > Thesis: *"How does the hybrid delivery format impact a student's engagement with a course, as measured through academic achievement and subject matter retention over time?"*
> > *Advisor:* Dr. Edie Schmidt

Rutgers University, College of Engineering, New Brunswick, New Jersey
> *B.S.*, Industrial Engineering, August 2000

EXPERIENCE

Academic Experience

Graduate Teaching Assistant, Purdue University, West Lafayette (January 2015 – Present)
> Responsibilities include all instruction, grading, student support and administration of assigned courses in the Supply Chain Management and Industrial Engineering Technology programs. Undergraduate courses include: *IT 332: Purchasing, Inventory and Warehouse Management; IT 385: Industrial Ergonomics; IT 450: Production Cost Analysis; IT 442: Production Operations; IT 490: Current Practices in Inventory Management and TLI 235: Introduction to Lean and Sustainable Systems.* Graduate courses include *IT 571: Project Management in Industry and Technology; IT 590: Special Topics in Supply Chain Management; TECH 646: Analysis of*

Research in Industry and Technology. Student survey data from the last academic year is presented in the student engagement section.

Grants Coordinator, Ivy Tech Community College, Lafayette (January 2015 – December 2017)
Responsibilities include writing new proposals, administering current awards, coordinating grant related activities, managing budgets, implementing new programs, creating sustainability initiatives and submitting reports as required. Awarded grants are recorded in a subsequent section.

Dean, School of Technology, Ivy Tech Community College, Lafayette (March 2012 – December 2014)
Responsibilities include managing the hiring of all full-time positions and the administration of all programs within the School of Technology, including budgets, grant management, recruitment, retention, and program development. The School of Technology at the Lafayette Region includes two-year terminal AAS degrees, AS transfer degrees, one-year Technical Certificates and certifications in Advanced Manufacturing, Automotive Technology, Design Technology, Energy Technology, Heating, Ventilation and Cooling Technology, and Industrial Technology. The programs are offered at four campuses within the regional area with an enrollment of approximately 1200 students, including full time, part time and high school dual credit students. Grants administered within these programs over the past five years in areas including: electric vehicles, energy technology, advanced manufacturing, smart grid technology and mechatronics. Additional responsibilities include articulation agreements with regional four-year institutions, course transfer agreements with high schools, representing the regional needs for trends in community college technical educational services, workforce development and service to various regional, statewide and national advisory committees. Awarded grants are recorded in a subsequent section.

Program Chair and Faculty, Ivy Tech Community College, Lafayette (January 2008 – March 2012)
Launched new regionally offered program in Advanced Manufacturing, including developing plans of study, authoring new courses, hiring additional full-time faculty, adjunct faculty and lab technicians, purchasing of necessary lab equipment, development of Summer Technical Middle College for high school student recruitment, facilitating advisory board meetings and student recruitment and advising. Industry relationships providing instruction for over 100 industry workers in the ADMF curriculum were created in conjunction with the WIRED scholarship and the CATERPILLAR Production Systems training program. Service learning opportunities at

regional employers were created, in areas of advanced manufacturing, logistics, quality and industrial technology.

In addition to instructional duties, several special curriculum projects were completed, including:

- Courses Developed for Statewide Implementation: including authoring all content, taught pilot course and distributing materials to all statewide ADMF programs:
  - *ADMF 101: Key Principles in Advanced Manufacturing; ADMF 102: Technology in Advanced Manufacturing; ADMF 106: Supervision and Teams at Work; ADMF 109: Green Manufacturing; ADMF 118: World Class Manufacturing; ADMF 119: Logistics in Manufacturing and ADMF 220: Work Cycle Analysis.*
- Courses Developed for Hybrid/Online Implementation: including development of Blackboard shell, taught pilot course and distributed materials statewide:
  - *ADMF 101: Key Principles in Advanced Manufacturing; ADMF 102: Technology in Advanced Manufacturing; ADMF 118: World Class Manufacturing; ADMF 119: Logistics in Manufacturing and ADMF 211: Quality Systems in Manufacturing.*

Industrial Experience

Project Consultant, Nice Pak Products Inc., Orangeburg, NY (November 2002 – December 2003)

Managing Team Leader, Hoffman La-Roche, Nutley, NJ (January 1999 – October 2002)

LICENSES, REGISTRATIONS, AND CERTIFICATIONS

Six Sigma Black Belt, Purdue University – 2017

Strategic Doing Facilitator, Purdue University – Center for Regional Development – 2014

Certified Technology Manager (ATMAE CTM), Association of Technology, Management and Applied Engineering (ATMAE) - 2014

Quality Engineer (ASQ CQE), American Society of Quality Certification – 2011

Certified Logistics Technician (MSSC CLA/CLT), Manufacturing Skills Standards Council – 2011

Ivy Tech Online Faculty Certification, Ivy Tech Community College – 2009

Internet Core Competency Certification, Certiport –2008

Certified Instructor and Certified High-Performance Technician (MSSC CPT), Manufacturing Skills Standards Council – 2008

<u>AWARDS</u>

Two-Year Excellence in Teaching Award – Association for Technology, Management and Applied Engineering – November 2016

Teaching Academy Graduate Teaching Award – Purdue University – April 2016

YWCA 2012 Salute to Women Award Nominee

Master Teacher – Academy for Instructional Excellence – Ivy Tech Community College Fall 2011

Excellence in Teaching Award Nominee – Ivy Tech Community College – Academic Years 2009, 2010 and 2011

Top 40 out of 40 Young Professionals Award – Lafayette Chamber of Commerce – 2006
　　　　　　Recognition for young professionals for career achievement and community service

<u>PUBLICATIONS AND CONFERENCE PROCEEDINGS</u>

Li, N., Ely, S., & Laux, C. (2017). How to Use Six Sigma Methodology to Improve Service Processes in Higher Education: A Case Study. In C. Laux, J. Antony, E. Cudney (Eds.), *Proceedings of the 4th International Conference on Lean Six Sigma for Higher Education* (129-145). West Lafayette, IN: Purdue Scholarly Publishing Services.

"How to Use Six Sigma Methodology to Improve Service Processes in Higher Education: A Case Study", at the 2017 International Conference on Lean Six Sigma for Higher Education, West Lafayette, Indiana

"Company and Agency Activities for ATE Grant Expansion", at the ATE PI 2016 National Conference, Washington D.C.

"Teaching the Teachers: Expanding Impact of Technical Education Through Secondary Schools", at the American Society for Engineering Education 2016 National Conference, New Orleans, Louisiana

"Implementing Industry Supported Advanced Maintenance Co-Op Programs", at the American Technical Educators Association 2015 National Conference, Indianapolis, Indiana

"Leveraging Partnerships for Increased Impact", at Hi-TEC 2015 National Conference, Portland, Oregon

"Career and Technical Education Recruitment Strategies: What's Cheap and What Works", at the ATMAE 2013 National Conference, New Orleans, Louisiana

"Integrations of STEM Community College Curricula and Industry Partnerships through National Certifications", at the ASQ 2013 Advancing the STEM Agenda 3rd Annual Conference, Grand Rapids, Michigan

Ely, S. (2013). Integration of STEM Community College Curricula and Industry Partnerships through National Certifications. *American Society for Quality STEM Journal* retrieved from: http://rube.asq.org/edu/2013/04/best-practices/integration-of-stem-community-college-curricula-and-industry-partnerships-through-national-certifications.pdf

"Embedding Energy Curriculum Across Multiple Technology Programs: A Collaborative Approach", at the American Technical Educators Association 2013 National Conference, Chattanooga, Tennessee

"Would you drink this? A Green Manufacturing and Chemical Technology Collaborative Lab Exercise", at the ATMAE 2012 National Conference, Nashville, Tennessee

"*Industrial Partnerships: Creating a Win-Win Scenario in Community Colleges with Local Industry",* at the ATMAE 2012 National Conference, Nashville, Tennessee

Ely, S. (2011). Chapter 5 – Monitor Environmental Aspects at Each Stage of Production IN: *Manufacturing Skills Standards Council Green Production Manual*, Virginia: MSSC

**"*Project Based Learning in Advanced Manufacturing: Engineering and Music Collide",* at the American Technical Education Association National Conference 2011, Minneapolis, Minnesota

Ely, S. (2010). *Exercises in Advanced Manufacturing: Safety and Quality Workbook.* Boston, Massachusetts: Pearson Custom Publications.

Ely, S. (2010). *Exercises in Advanced Manufacturing: Production and Maintenance Workbook.* Boston, Massachusetts: Pearson Custom Publications.

"How does the hybrid delivery format impact a student's engagement with a course, as measured through academic achievement, subject matter retention over time, student satisfaction and collaborative engagement with fellow students?" at the ATMAE 2010 National Conference, Panama City, Florida

GRANT AWARDS AND ADMINISTRATION

Principle Investigator – National Science Foundation – ATE Logistics Grant – (April 2013 – July 2018) Logistics curriculum development and implementation - $455,317 awarded

Principle Investigator – Alcoa Foundation Grant – (July 2014 – December 2017) Workforce training sponsoring scholarship and awareness activities in manufacturing. $250,000 awarded

Principle Investigator – Duke Energy Foundation Grant – (July 2014 – December 2017) Development and implementation of workforce training and job placement for manufacturing careers. $299,000 awarded

Co-Principle Investigator – Macomb Community College Minigrant – (February 2012 – March 2014) Alternative Energy curriculum development and implementation - $22,000 awarded

Regional Administrator - Department of Labor TAACCCT STEM Grant – (October 2011 – September 2015) Open Source curriculum development and implementation for electric vehicles - $2.4 Million awarded

INDUSTRY SPEAKING ENGAGEMENTS

"At the Crossroads – Preparing the Logistics Workforce of the Future", at the Indiana Logistics 2014 Summit, Indianapolis, Indiana

"Advancing Manufacturing and the Workforce Skills Gap", at the Society of Human Resources 2014 conference, Michigan City, Indiana

"Office Value Stream Mapping and A3 Reporting", Wabash Valley Lean Network Presentation

"What does Quality mean to me?" – Guest Speaker at the Lafayette ASQ Chapter, September 2009

SERVICE AND STUDENT ENGAGEMENT

Association for Technology, Management and Applied Engineering, Board of Directors (2014 – 2016) and Executive Board Member (2015 –2016) and Treasurer of the Board (2015 – 2016)
Service to the ATMAE professional organization through oversight of activities, conferences, publications, accreditation activities, recruiting and professional development opportunities.

Faculty Advisor, Students for Academic Success and Service, Ivy Tech Community College, Lafayette (2010 – 2012)

Initiated and obtained school wide recognition and funding for a student organization supporting students who are affiliated with the Tippecanoe County Corrections System at Ivy Tech Community College.

Faculty Co-Advisor, Women in Science and Technology, Ivy Tech Community College, Lafayette (2008 – 2010)

Initiated and obtained school wide recognition and funding for a student organization supporting women in all areas of science and technology at Ivy Tech Community College.

STUDENT SURVEY DATA – 2017–2018

Course taught	IT 57100	IT 332	IT385	IT 435	IT 442	TLI33520
Semester and year	SU/ 2018	SP/ 2018	SP/ 2018	SP/ 2018	FA/ 2017	FA/ 2017
Number of respondents/ Enrollment	6/6	22/37	13/39	13/25	31/44	19/22
Overall, I would rate this instructor as:	4.9	4.8	4.9	4.9	4.7	4.7
The content of this course is consistent with the objectives of the course.	4.9	4.9	4.4	4.7	4.7	4.6
The teaching methods used in this course enable me to learn.	4.8	4.8	4.6	4.8	4.6	4.3
Exams accurately assess what I have learned in this course.	4.8	4.8	4.6	4.9	4.7	4.6
My instructor seems well-prepared for class.	5.0	4.9	4.7	4.7	4.6	4.6
My instructor is actively helpful when students have problems.	5.0	4.9	4.8	4.8	4.7	4.6
My instructor uses appropriate course delivery methods.	5.0	4.9	4.6	4.7	4.6	4.6