IMPROVING FACULTY PROFESSIONAL DEVELOPMENT FOR COMMUNITY COLLEGE SCIENCE EDUCATORS

by

Alfred Noubani

An executive position paper submitted to the
Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Doctor of Education in Educational Leadership

Fall 2018

© 2018 Alfred Noubani
All Rights Reserved

IMPROVING FACULTY PROFESSIONAL DEVELOPMENT FOR COMMUNITY COLLEGE SCIENCE EDUCATORS

by

Alfred Noubani

Approved: _____
Chrystalla Mouza, Ed.D.
Director of the School of Education

Approved: _____
Carol Vukelich, Ph.D.
Dean of the College of Education and Human Development

Approved: _____
Doug Doren, Ph.D.
Interim Vice Provost for the Office of Graduate and Professional Education

I certify that I have read this thesis and that in my opinion it meets the academic and professional standard required by the University as an executive position paper for the degree of Doctor of Education.

Signed: _____

Fred Hofstetter, Ph.D.
Professor in charge of executive position paper

I certify that I have read this thesis and that in my opinion it meets the academic and professional standard required by the University as an executive position paper for the degree of Doctor of Education.

Signed: _____

Doug Archbald, Ph.D.
Member of executive position paper committee

I certify that I have read this thesis and that in my opinion it meets the academic and professional standard required by the University as an executive position paper for the degree of Doctor of Education.

Signed: _____

Lauren Bailes, Ph.D.
Member of executive position paper committee

I certify that I have read this thesis and that in my opinion it meets the academic and professional standard required by the University as an executive position paper for the degree of Doctor of Education.

Signed: _____

Richard Kralevich, Ed.D.
Member of executive position paper committee

ACKNOWLEDGEMENTS

I would like to acknowledge my advisor, Dr. Fred Hofstetter, for taking me under his wing and providing the direction and motivation I needed to complete this work. His patience and encouragement helped me get the job done. Thanks Dr. Fred, you got me through it!

I would like to thank my committee, Dr. Lauren Bailes, Dr. Rick Kralevich, and Dr. Doug Archbald. With their direction and support, I got some great ideas and assistance with getting worthwhile resources. Doug, Qualtrics is my friend thanks to you. Lauren, my lit review was about 200 more papers, but I thought of you being concise and clear. Rick, professional learning communities "rock". I want to try one for our department.

The administrators, faculty and staff at Delaware Technical Community College who supported me include John Buckley, Bill Morrow, June Turansky, Justina Sapna, Rick Kralevich, Jason Cox, Stacey Hoffer, Dora Eyong, Lakshmi Cyr, John Kaminski, Lori Maramante, Nick Liberti, and Jim Devenny.

I would also like to give a heartfelt thanks to my mom, Huguette Barakat. We can say one thing about "Nona": she is persistent and always telling you, "it's okay, you'll get it done", and "come on, get it over with". Talk about a motivator. Thanks mom, this is for you.

I also want to thank my son, Aiden. He took out Thorton without any fuss, took care of the chores, and gave me space and time to finish this work. Now it's time to play B-ball and other sports.

I also need to thank our wonderful friends, Rick Hodgson and Ny Wnek. You have to love people that love their dog as much as they do. They took care of our dog, Thorton, for months, by taking him out during the day while I stayed at work to write after hours and then they came in the evening and took Thorton for a playdate with their dog, Danny. (Bow!) Wow! What friends.

Finally, I want to thank my amazing wife, Naomi Machell. She's got everything you always want in a soulmate – she is beautiful in and out, she never says a mean word, she has helped out on everything while I was writing, and she has always found time to stay cheerful and supportive. It's no joke when I say she's the smart one. You can't find someone like that in a million years. I know we help each other, but she really gave her all. Naomi, I adore you!

TABLE OF CONTENTS

LIST OF TABLES viii
LIST OF FIGURES ix
LIST OF ABBREVIATIONS x
ABSTRACT xi

Chapter

1 INTRODUCTION 1

1.1 Improving Teacher Quality 1
1.2 Problem Statement 5
1.3 Organizational Improvement Goal 7

2 LITERATURE REVIEW 14

2.1 Needs of Science Education 14
2.2 Instructional Needs of Science Education 17

2.2.1 The Way Students Learn 17
2.2.2 Bridging the Knowledge Gap 19
2.2.3 Student-Centered Learning 20

2.3 Professional Development in Higher Education 27
2.4 Science Professional Development in Higher Education 30
2.5 Evaluation of Science Professional Development in Higher Education 34
2.6 The Power of Learning Communities 40

3 METHODOLOGY 44

3.1 Purpose 44
3.2 Executive Position Paper Questions 44
3.3 Study Instruments 46

3.3.1 Surveys 46
3.3.2 Population description 47

3.3.2.1 Faculty 47
3.3.2.2 CCIT staff 48
3.3.2.3 Science department chairs 48

4 RESULTS 49

4.1 Key Question 1 49
4.2 Key Question 2 52
4.3 Key Question 3 57
4.4 Key Question 4 64
4.5 Key Question 5 66
4.6 Key Question 6 69

5 CONCLUSIONS AND RECOMMENDATIONS 73

5.1 Rethinking Traditional Instruction 73
5.2 Findings 79
5.3 Program Strengths 80
5.4 Recommendations for Program Improvement 81

REFERENCES 89

Appendix

A SURVEY PROTOCOLS 106

A.1 Science faculty 106
A.2 CCIT staff 119
A.3 Science Department Chairs 129

B INSTITUTIONAL RESEARCH BOARD 139

B.1 DTCC – Research Approval Request 139
B.2 CITI Program – Human subjects certification 145
B.3 Exemption letter 147
B.4 Human Subjects Protocol 148

LIST OF TABLES

Table 1: Science Faculty, Science Department Chairs, and CCIT Staff Ratings of the Importance of Skills for Science Students..…….51

Table 2A: Comparison of Science Department Chairs and CCIT Staff Ratings of the Importance of Various Instructional Practices to Student-Centered Learning (Mean Ranking)..…….…….…..……..…53

Table 2B: Comparison of CCIT Staff, Science Department Chairs, and Science Faculty Ratings of the Importance of Two Instructional Practices to Student-Centered Learning (Mean Ranking)...…….……..…54

Table 3: Reported Use of Instructional Practices by Science Faculty..……...…….59

Table 4: Science Faculty, Science Department Chairs and CCIT Staff Ranking of the Benefits of Various Instructional Development Opportunities..……70

LIST OF FIGURES

Figure 1. Conceptual Framework: The Relationship Between Professional Development Design, Implementation, and Evaluation for Science Faculty to Increase Student-Centered Instruction in Science Classes. ..…….. 13

Figure 2. Top Five Instructional Practices that Promote Student Retention in High-Enrollment / High-Attrition Science Courses According to CCIT Staff and Department Chairs. ……..…….……..……56

Figure 3. Comparing Instructional Practices Used by Faculty to Those Chosen to Promote Student Success by CCIT in a High Enrollment / High Attrition Course (Means of Ranked Scores). ……..……..…61

Figure 4A. Effective Use of Science Faculty Instructional Practices Observed by Department Chairs. ……..…..……..……63

Figure 4B. Identification of Science Faculty Instructional Methods Observed by Department Chairs. ……..……..…..……64

Figure 5. Training Opportunities for Faculty Offered by CCIT as Reported by CCIT Staff. ……..…..……..…65

Figure 6. Science Faculty and CCIT Staff Ratings of How Often Assessment Types Are Used and Which Ones Are Most Student-Centered. ……..…..……68

Figure 7. Comparisons Among Science Faculty, Science Department Chairs, and CCIT Staff Ratings of the Benefits of Professional Development Opportunities...…72

LIST OF ABBREVIATIONS

AAAS – American Association for the Advancement of Science

ANOVA – Analysis of Variance

CCIT – Center for Creative Instruction and Technology

DBER – Discipline-based education research

DCs – department chairs

df – degrees of freedom

DTCC – Delaware Technical and Community College

F – F statistic

FLC – Faculty learning community

M – mean

NAE – National Academy of Engineering

NAS – National Academy of Science

NASEM – National Academy of Science Engineering and Medicine

NFD – new faculty development

NRC – National Research Council

PD – professional development

PDK – pedagogical content knowledge

SD – standard deviation

ABSTRACT

Introductory biology and chemistry courses have some of the highest attrition rates at Delaware Technical Community College. High attrition rates in undergraduate Science, Technology, Engineering and Mathematics (STEM) courses are also present on a national scale (Chen, 2013). Research in student success points to a lack of student-centered pedagogical practices, providing a less engaging learning environment. However, engagement is particularly important in STEM fields (AAAS, 2010; NRC, 2005). Such student-centered practices could be attained through professional development activities. Faculty professional development efforts at Delaware Technical Community College include training topics in instructional design and educational technology. The aim of this executive position paper was to use a survey instrument to evaluate (1) what science faculty members believe are important skills for science students, (2) how best to teach those skills, (3) what instructional methods science faculty self-report using in class, and (4) what areas of the professional development program are available for faculty. The survey was distributed to the science faculty, science department heads, and professional development staff. The survey results indicate that all three groups agree on the skills science students need to be successful in their field. The data also reveal that all three groups consistently identified the student-centered instructional practices that national reports identify as effective teaching methods in the STEM disciplines. Contrary to knowing which strategies benefit student learning, science faculty report using lectures as their primary instructional practice and predominantly employing assessment techniques such as multiple-choice questions. This project has identified eight recommendations

that would benefit science faculty development to potentially increase STEM student success: 1) embrace active learning, 2) leverage faculty learning communities, 3) improve communication and embrace understanding, 4) understand trends in professional development, 5) celebrate our successes, 6) leverage the power of peer observations, 7) help faculty target student study skills in their pedagogy, and 8) redefine what it means to be a scientist and an instructor.

Chapter 1

INTRODUCTION

1.1 Improving Teacher Quality

Improving the quality of teaching has been of interest and concern to all levels of government as well as educational institutions for well over a century. As early as 1911 the U.S. Secretary of the Interior, Elmer Brown, recommends that teacher training be considered valuable for three reasons: (1) teachers begin their practice relatively untrained, (2) training can only be completed once the teaching practice has started, and (3) teaching is iterative, and a lack of continual training will result in less than effective practice (Ruediger, 1911). The report that accompanies this letter describes the K-12 teacher training activities that introduce teachers to general pedagogical improvement strategies followed by discipline-specific review sessions (Ruediger, 1911). In a similar federal report from the U.S. Office of Education, Kelley (1950) writes that the results of a survey sent to the presidents and deans of every university, college, liberal arts college, teachers college, and technical college nationwide identified three key areas of improvement for teachers of higher education. The three issues that college administrators identified were (1) narrow disciplinary training of faculty members, (2) too much faculty time and effort on research, and (3) little faculty training in pedagogy.

According to Kelley (1950), when one completes his or her terminal degree, he or she is unable to make connections with other disciplines due to the degree of specialization. Kelley further states that teachers experience instructional challenges due to insufficient pedagogical knowledge. Overall, faculty believe that their teaching duties are only a necessary means to their main professorship goals (Kelley, 1950). Creating change in classroom behavior is accomplished when teachers' beliefs and attitudes change toward the importance of creating a student-centered learning environment (AAAS, 2010; Guskey, 1986). The benefit of student-centered instruction on student performance has been shown across disciplines and educational levels (AAAS, 2010; Elliot, 2016; McKeachie, 1971B). Behavioral and attitudinal changes are facilitated by providing teachers with appropriate and directed professional development training (Guskey, 1986).

The AAAS (AAAS, 2010) and the advisory group to the President (Olson, 2012) assert that attrition rates and science, technology, engineering, and mathematics (STEM) graduate numbers will remain static unless two- and four-year colleges and universities change the culture of instruction. Schools of higher education must review the overwhelming evidence that points to the need for undergraduate educators to introduce instructional practices that create a student-centered learning environment to bolster the retention, persistence, and overall success of science students (AAAS, 2010).
The implementation of student-centered learning increased students' grades overall in an introductory oceanography class (Yuretich, 2003) and increased the number of students enrolled in an engineering program (Bernold, 2007). One of the main factors behind

student persistence and graduation is the effective use of active learning and other learner-centered instructional practices in the classroom.

The American Association for the Advancement of Science (AAAS) published a report (AAAS, 2010) revealing that the number of college students completing baccalaureate degrees in STEM disciplines has steadily decreased over the past three decades. The report attributes this decline to the inability of the instructional practices used in class to meet the needs of the various students striving to understand STEM concepts. In a national report on attrition rates in undergraduate education, Chen (2013) reveals large undergraduate student attrition rates of 69% and 28% in science programs at two- and four-year colleges, respectively. At a small northeastern liberal arts college, Rask (2010) notes that from 2001 to 2009, of the 1,682 students enrolled in introductory biology courses in their first semester, nearly 50% had withdrawn from the program by the second semester, and only 10% remained in the program in the fourth semester. The variables that directly contributed to these attrition rates were the final grade at the end of the first semester and SAT scores prior to college entry (Rask, 2010). The results presented by Rask (2010) may reflect at least one reason why the STEM attrition rates are high on a national scale. A report by the advisory group on science and technology to the President of the United States predicts a growth of one million STEM-related occupations in 2018 (Olson, 2012). One million more jobs equates to increasing the number of associate and baccalaureate degrees attained in the STEM fields by 33% or 100,000 more graduates per year (Olson, 2012).

The science department at Delaware Technical Community College (DTCC) provides general education and program-specific courses to approximately 85% of the student population, yet many of these courses also have the highest attrition rates compared to non-science courses.[1] Low student retention and high course attrition lead to fewer graduates in the allied health, nursing, and science transfer option programs. The college administration has instituted a professional development (PD) center that offers training to all faculty for the development of pedagogical skills with the intention of increasing student success and retention in the science and non-science fields.

The Center for Creative Instruction and Technology (CCIT) provides all full-time and adjunct faculty and academic advisors with support, education, and training to create an instructional capacity that merges content knowledge with effective instructional practices and technology applications. A subset of CCIT is the New Faculty Development (NFD) program—a mandatory training program for all new full-time faculty and counselors at the college. Together, CCIT and the NFD program offer multiple PD course topics that all faculty and counselors from any discipline can utilize to enhance their knowledge of technology or pedagogy. Utilizing effective pedagogy is crucial for the academic success of STEM students, and CCIT offers to the science faculty many PD options that introduce new techniques and allow for honing of their instructional skills. The goal of this project was to evaluate the PD needs of science faculty specifically related to their discipline. Based on this evaluation, my objective was

[1] DTCC data report in 2016

to provide the CCIT administration with a set of recommendations that can be used to further enhance the effectiveness of the program's PD offerings.

1.2 Problem Statement

The AAAS report (AAAS, 2010) recommends that educators incorporate student-centered learning practices that engage students in the classroom with inquiry-rich learning experiences that reflect the cognitive principles of how people learn. Numerous studies have identified effective teaching and learning practices which promote student learning and improve student achievement, yet, for various reasons, higher education still relies on the less-effective traditional, lecture-based format (Hativa, 1993; Kardash, 2001; Van Amburgh et al., 2007). This method of instruction creates an environment where students are required to listen, absorb, and retain information without making any transformative connections with other elements of the course material. This learning modality reduces student engagement with the content matter and hinders comprehension (AAAS, 2010). As Van Amburgh (2007) states, "we need to have mechanisms that promote real change and growth in faculty teaching skills and that capture the reality of the classroom" (p. 5), implying that a change in the instructional method will consequently change the classroom atmosphere in promoting student learning.

One consequence of the limited use of active learning approaches in science classrooms is the high attrition rate of students in associate degree programs in health sciences (Chen, 2013). Undergraduate students enrolled in traditional, lecture-based undergraduate biology courses had higher levels of attrition compared to similar students

who received active learning instruction (Daempfle, 2003; Feldon, 2010). Chen (2013) observes that 20% of the students seeking an associate's degree, during the 2003-2004 academic year, entered a STEM field, and within the six-year graduation cycle (2003-2009), 69% of those students either switched disciplines or never completed their degree. There was a correlation between increased attrition rates and the following student academic characteristics: enrollment in remedial math courses, low grades in STEM courses, and a low cumulative grade point average by the end of the first year (Chen, 2013). Ineffective teaching strategies and a passive learning environment appear to positively correlate with the declining student success in science courses (Kardash, 2001). The AAAS (2010) describes ineffective teaching as a teacher-centered approach whereby the instructor is providing information during a class session while the students are passively absorbing the content, are not engaged in the learning process, and do not have the opportunity to form connections with other aspects of the content. Colleges and universities should understand the importance of providing students with a learner-centered educational experience (Kardash, 2001).

Institutions of higher education should focus on creating a PD program that promotes faculty to create an educational environment that fosters active, student-centered learning, which will ensure the continued progression of science literacy in our citizenry (NASEM, 2016b). Science faculty need to understand the teaching strategies that provide students with the opportunity to engage in the course content and enrich their classroom experiences to increase student outcomes. An effective PD program at a post-secondary institution would design and implement a training PD curriculum that supports

the science faculty in their efforts to transform the classroom from a teacher-centered to a student-centered environment. Therefore, determining the extent to which a PD program furnishes faculty with the appropriate training is essential to generating science-competent graduates. Marbach-Ad et al. (2014) describe an evaluative framework for assessing PD congruence with the science faculty's needs and identify several instructional strategies that are beneficial for student-centered teaching, which students and faculty members confirm is not utilized in the classroom. This framework includes identifying the perceptions of science faculty, teaching assistants, and undergraduate students regarding student-centered learning. It also includes assessing to what extent science faculty use student-centered teaching approaches and how PD professionals are supporting science faculty by providing training opportunities (Marbach-Ad et al., 2014).

1.3 Organizational Improvement Goal

As part of DTCC's mission, the college strives to provide "programs, activities, and services [that] will cultivate student learning and success"[2]. Thus, as part of the college mission, the organizational improvement goal is to increase student success rates at the institutional level. To address this goal DTCC provides PD opportunities for all full-time and adjunct faculty with the intention of improving instructional practices and thus promoting student success.

[2] DTCC home page

At a departmental level, the instructional practices of science faculty directly impact the success of 85% of the student population, making it one of the largest departments according to student enrollment records.[3] College data show that the average attrition rates for entry-level biology and chemistry courses are higher than for other courses offered at the college. College administrators are concerned about the attrition rates in these high enrollment courses, and the organizational improvement goal is to address this issue and improve student performance and success.

Two ways the college has addressed the issue of high attrition science classes are: (1) by redesigning some of the first-semester prerequisite science courses and (2) by increasing science faculty access to course-specific instructional innovations through a developmental course shell. The course redesign process is intended to increase student success by defining and aligning the course content, assessments, and laboratory exercises on all campuses. The sharing of instructional strategies and practices between science faculty is via access to a course shell. The course shell is organized into unit objectives and science faculty freely download, and upload, instructional tools used for each objective (i.e. case study, clicker questions, engagement activities, assignment questions). Despite these efforts, attrition rates in introductory biology and chemistry classes remains over 60% and preparing and maintaining skilled faculty to teach college level science courses is a persistent endeavor. Therefore, the improvement goal of the college, to increase student success, transcends into the science department goal because

[3] DTCC registrar report in 2016

introductory science courses are necessary requirements for a majority of DTCC students. DTCC departmental and institutional changes that support science faculty instructional improvements could lead to increased science student success.

Together, several reports identify seven barriers that might explain why low pass rates remain a challenge in science courses: (1) the science faculty is unaware of the best practices to teach science students, (2) community college students come unprepared or underprepared for the rigors of content-heavy science courses, (3) the science faculty does not receive support from the department or institution in the form a reduced work load to pursue development efforts, (4) a lack of funding for technology or travel expenses to conferences on pedagogy, (5) no reward structure for improvements, (6) faculty members' beliefs about their instructional effectiveness, and (7) a PD program that does not offer discipline-specific pedagogical training (AAAS, 2010; NASEM, 2016a; Olson, 2012).

The seven barriers to college science course success identified in the aforementioned reports are borne out by further studies. Chapter 2 reviews educational and federal reports giving evidence that students learn through various modalities which develop their cognitive skills, yet faculty are unaware or unable to accommodate these modalities. The presence of unprepared and underprepared students in college has been documented in several studies. In California community colleges, the number of first-time students that test below college level math and English skills is 90% and 70%, respectively (Carnegie, 2008). Nationally, Boswell (2004) reports that the number of first

time students underprepared for the challenges of college coursework reaches almost 50%. At DTCC the number of new students needing to take pre-tech (remedial) courses in math and English in their first semester exceeds 50%.

Regarding institutional support of faculty release time for professional and curriculum development, institutions should recognize that in order to effectively implement student-centered instruction, faculty need time to revise curricula, experiment with new equipment, and design the classroom lesson, in addition to pursuing professional development opportunities (NASEM, 2015). In reference to DTCC, full time faculty are scheduled to teach 18 contact hours per week with a teaching load reduction given only when a faculty member has over 48 student advisees. There is no reduction in teaching load or specific time off for professional or curriculum development. This results in little opportunity and incentive of faculty to introduce new teaching and learning approaches. Institutional support in the way of funds is also a barrier for science faculty professional development. The NRC (1996) reports that colleges and universities have not provided adequate funding for travel expenses associated with educational training for faculty. This is either due to institutions diverting the resources toward research, technology improvements, or infrastructure.

At DTCC, the combination of reduced state funding support and lower student enrollments has created a significant gap in the available resources the college allocates to faculty for travel expenses. Prior to the 2012 academic year, the instructional division did provide limited funding for association subscriptions, class field trips, and instructional supplies outside the regular budget requests.

The NRC (1999) reports that as a nation, we have an inadequate understanding of STEM as it relates to developing and using technology in the global environment. In order to ameliorate this knowledge gap, the NRC proposes that all undergraduates are given the opportunity to experience STEM subjects as they are practiced by scientists and engineers and that those experiences are student-centered. To address the instructional objective, the NRC (1999) recommends that postsecondary institutions offer incentives to faculty and departments to improve instructional practices in the form of recognition, financial support, the addition of new technology, replacement of equipment and participation in PD. Full-time faculty at each campus of DTCC are eligible for a teaching award once a year based on the nomination from a supervisor, colleague or student. The reward is the public announcement of the award at the college's yearly recognition event, a token medal and the unpaid opportunity to participate in a study abroad experience. Faculty recognized for their teaching excellence are not awarded monetary or work incentives, such as a reduced work load, nor are they invited to present their classroom practices to the college community through PD presentations.

With regard to faculty beliefs about their teaching effectiveness, Marbach-Ad (2014) reports that science faculty believe that utilizing active learning and student-centered instructional approaches support undergraduate students in understanding science theories. Yet, it is also reported that the majority of STEM faculty are delivering course content through a lecture format rather than utilizing more student-centered practices (AAAS, 2010).

The availability of discipline-specific PD opportunities is important as Avery and Reeve (2013) report that an effective PD program will incorporate data-driven pedagogical strategies with content knowledge. For the STEM disciplines it would mean creating a PD program that involves multidisciplinary faculty working cooperatively to understand student objectives and develop an instructional practice that meets those objectives (Carnegie, 2008). Presently, CCIT does not offer discipline-specific PD as part of the general course offerings, but one-on-one training and group training has always been an optional choice for faculty and departments. To support the organizational improvement goal, PD for science instructors can help lead to more effective teaching and therefore, increased science student success.

Figure 1 provides the conceptual framework of this survey project. The design is based on the understanding that PD, instructional improvements, and program evaluations are all iterative processes. The apex of the framework is the PD design, which offers faculty training opportunities on the topics of technology, pedagogy, and student learning theories in formats ranging from workshops, formal courses and group settings, to one-on-one training sessions. New, mid-career, and senior faculty members participate in various elements of the PD curriculum and transform their classrooms with improved student-centered instruction.

As the AAAS report (AAAS 2010) recommends, improving science instruction by increasing the use of learner-centered approaches in the classroom may lead to augmented student outcomes, increased student retention and persistence to graduation

with a concomitant a reduction in attrition rates. In 2002, Guskey described faculty professional development as a "systematic effort to bring about change in classroom practices" by transforming teacher "attitudes and beliefs" to improve student outcomes (p. 381). According to Guskey (1986), the PD activities have the potential to transform classroom practices directly which corollate to a change in student outcomes. Therefore, the organizational improvement goal of this executive position paper is to set forth a series of science-specific professional development recommendations which, when correctly implemented, will produce increased student achievement. These recommendations will align with the conceptual framework outlined in Figure 1. Once these professional development recommendations have been outlined, I will share these findings with CCIT and Senior Administration in order to collaborate on a solution and plan a path toward implementation.

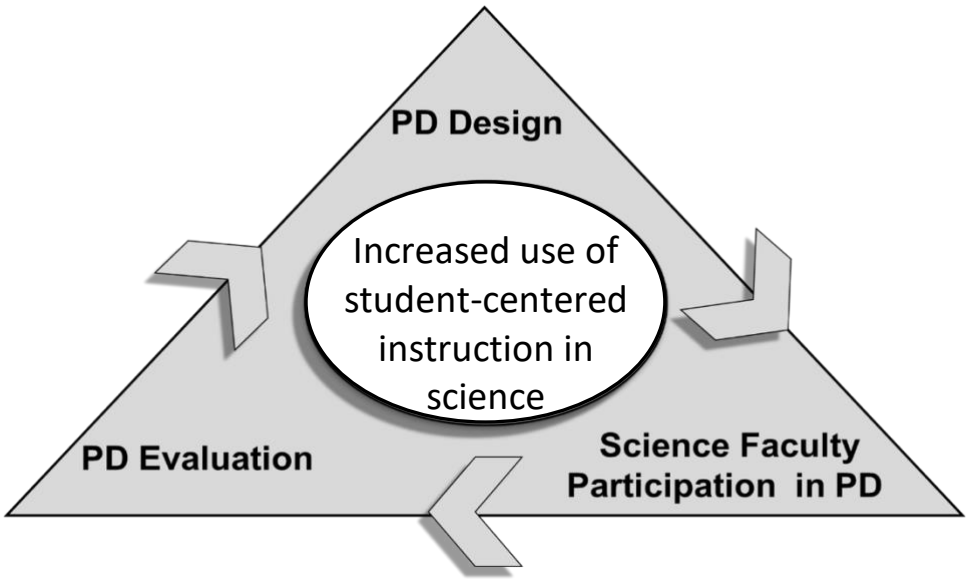


Figure 1. Conceptual Framework: The Relationship Between Professional Development Design, Implementation, and Evaluation for Science Faculty to Increase Student-Centered Instruction in Science Classes.

Chapter 2

LITERATURE REVIEW

2.1 Needs of Science Education

More than a century ago, educators already understood the challenges and benefits of a science curriculum. In the *Fortnightly Review of 1916*, Brudenell Carter discusses the importance of using illustrations in science education: "experimentally illustrated lectures adapted to the intelligence of the classes, senior or junior, for whose benefit they were delivered, to awaken the minds of boys to the nature and realities of science" (in DOE, 1917, p. 7). Furthermore, in *School Science and Mathematics of 1916*, Flora Hook contends that science would "familiarize the pupil with his environment, and with the laws which govern the world; to teach him life principles by a study of natural forms, that he may master… the resources supplied him" (DOE, 1917, p. 8). The need to improve instruction at all levels of education and specifically within the science disciplines has been an issue for decades, and understanding that students learn not only from what is taught but how that knowledge transforms their beliefs is the fundamental purpose of improving teaching practices through PD.

The National Academy of Sciences (1996) reports that a review of colleges and universities identified many encouraging gains in the education of students within the STEM fields. Some of these successes include greater course options, incorporation of applicable job skills, and production of motivated students who will complete

postgraduate education. However, the report also states that some curricula only included a small percentage of science or technology courses, and that many of these courses did not engage the students in the methods of science and the processes of scientific discovery (NAP, 1996), while the professors were actively pursuing exciting areas of research. The consequences of these pitfalls were a low graduation rate and a high attrition rate in the science fields (Alpert, 1985; Chen, 1996; Chen, 2013).

Chen (2009) reports that of the 23% of students entering a four-year college to pursue a STEM major in 1996, by 2003, 55% had switched into another major and 27% had withdrawn. By 2013, the attrition rates in four- and two-year colleges were higher than in the 2009 report, showing that 48% of baccalaureate and 69% of associates enrolled in STEM programs had switched or departed the college after enrolling in 2003 (Chen, 2013). The high rate of attrition in STEM and allied health fields has sparked a national discourse on the future of STEM education. On a global level the United States plays an important role in climate change, economic development, and social equity issues as population demographics shift (Beach et al., 2012). If the number of STEM graduates continues to decline, our involvement and influence in global affairs would be diminished (Beach et al., 2012).

Several national publications have identified various reasons for the high level of student departure from STEM majors. The California Community College Chancellor's Office reports that the number of first-time California community college students testing below criteria in college math is 90% (Carnegie Foundation for the Advancement of Teaching, 2007). Chen (2013) confirms that at the national level, 46% of students will

drop out of college if they had a high school grade point average below 2.5 and 41% if they did not complete high school algebra or trigonometry. Furthermore, the National Academy of Sciences reports that one way to improve retention and persistence in undergraduate STEM majors is to create an instructional atmosphere that relates science to real-world problems (NAP, 1996).

Effective changes in teaching and learning rely on understanding various student characteristics and cognitive learning strategies, which create a stimulating learning environment. Today's college classroom has students from different ethnic, cultural, and socioeconomic backgrounds, with diverse work and educational experiences. Understanding how to communicate verbally, kinesthetically, and visually will benefit the greatest number of students by generating a student-centered learning environment. Changing the model of education is not a new concept, as Tobias (1992) describes, science education reform has been a discussion topic among government agencies and academic institutions since the launch of Sputnik. Furthermore, Tobias identifies three themes that education researchers believed, at the time, to be the cornerstones of science education reform. The themes described that: 1) one curriculum or pedagogy exists that will work in any class environment for any discipline, 2) the curriculum or pedagogy will be identified through data-driven empirical research, and 3) all educators will endorse and implement the newly discovered and proven practice (Tobias, 1992).

The "one method" approach, described by Tobias (1992), suggests that there is only one instructional strategy to student success, and this is clearly not the case. The research conducted since 1992 has revealed two key components of academic

achievement, which encompasses the idea that increasing student success will have to come from changing instruction by moving away from the traditional lecture format (teacher-centered) and implementing teaching practices that complement the ways in which students learn (student-centered). The National Survey of Student Engagement of 2005 revealed that educators from 20 of the top achieving universities communicated frequently with other college faculty who demonstrate student-oriented practices, provided frequent performance feedback to students, and reviewed their instructional practices through assessments (Cambridge, 2005). The American Association for the Advancement of Science's extensive literature review of teacher and student performance points to a need to support student learning by creating a constructivist instructional approach (AAAS, 2010). As Biggs (1996) describes constructivism, it is the learner's creation of meaning which is measured qualitatively, and knowledge development is dependent on the learner, not the teacher. The constructivist design follows the scheme introduced in the How Students Learn (AAAS, 2010) report, which describes the understanding of students' preconceptions, their changing foundations based on discovered facts, and the metacognition that the newly formed knowledge fits into their understandings.

2.2 Instructional Needs of Science Education

2.2.1 The Way Students Learn

During the past half-century, the STEM disciplines have advanced with increasing content complexity. This has underscored the need to understand effective

teaching strategies which promote student learning to maintain or increase the number of graduates in these subject areas. In a National Research Council (NRC) report titled *How Students Learn*, Bransford and Donovan characterize learning science in the traditional style of lecturing as the reproduction of facts provided from reading a textbook or listening to a lecturer, with the possibility of engaging in experimentation (NRC, 2005). Taking science education to a level that motivates students to acquire knowledge at the higher level of Bloom's (1956) taxonomy requires teachers to address three components of learning. First, they must recognize that students come with preconceived ideas about how the world works, and that using those foundations to cultivate new, adaptive ideas helps construct students' understanding of the content being introduced (NRC, 2005). Second, the integration of new knowledge with pre-existing knowledge does not proceed unless a conceptual framework, based on foundational information, is first established (NRC, 2005). This allows students to adopt new content in a context that satisfies their pre-existing foundation of knowledge, similar to expanding the application of eggs as not just a breakfast meal but also for baked goods, due to the chemical nature of the egg white and yolk. Third, students need to verify their comprehension through self-assessment so that their progress aligns with the learning goals of the course—a process called metacognition (NRC, 2005). Taken together, students learn by gathering information, either directly or through experimentation, and shape their preconceptions in order to generate a framework of knowledge that has the flexibility to incorporate new ideas. The process of learning should resemble an educational experience that fosters a student's intellectual growth and thereby start with an instructional strategy that

stimulates a student's ability to question new ideas, test new theories, and make connections that expand knowledge—a student-centered approach.

2.2.2 Bridging the Knowledge Gap

What does the faculty need to do to increase student achievement and create a learning environment that supports students from diverse educational, cultural, and socioeconomic backgrounds? According to the National Research Council (1999b), the U.S. population includes a small technologically literate group and a large group with little-to-no knowledge of technology or science (NRC, 1999b). To bridge the gap between these two groups, the U.S. Department of Education (2007) recommends improvements in K–12 education in the subjects of mathematics and science including strengthening the rigor of the curriculum, increasing access to advanced placement courses, and promoting quality instruction by revising post-secondary teacher training programs (DOE, 2011). Extending these recommendations to the undergraduate level, the NRC (1999b) endorses exposing all college students to science in a manner that supports lifelong learning of science.

An essential element for increasing students' understanding of science would be for the faculty to utilize instructional practices that engage the students and cultivate learning. The AAAS (2010) describes the implementation of active-learning as students performing experiments, formulating hypotheses and analyzing data, and creating understandings of two or more ideas into one overarching concept which is a form of engagement. The faculty can achieve this by implementing a multifaceted approach at

the institutional, department, and instructional levels. Departments and faculty members can adopt a two-pronged approach by integrating the science curriculum with societal issues and by creating an active learning process in the classroom (NRC, 1999b). Implementing active learning in the instructional process is not an overnight task that will yield instant results, yet it will work for all types of subjects, content, and students. In fact, considering what Coil et al. (2010) describe as learning the process of science, the faculty must implement multiple instructional practices in order for students to effectively solve problems, integrate information, interpret data, work collaboratively, and have the ability to communicate orally and in writing. In other words, the instruction will help students develop their ability to understand concepts and theories by experiencing the process of scientific inquiry and making connections with pre-existing knowledge to generate further inquiries (NRC, 2005).

2.2.3 Student-Centered Learning

Active learning instruction can manifest in the classroom in various ways. Before some of these approaches are introduced, it should be noted that student learning is not just a function of the instructional methods that are used but how those approaches coalesce with the qualities the student brings to the class and how those qualities integrate or contrast with the qualities of the other students and the instructor. The NRC (2005) identifies students' preconceptions as one of the main elements to consider when creating a student-centered learning environment. However, it is important to recognize that these preconceptions include diverse personal characteristics. Kimberly Tanner (2013)

identifies these traits as prior experiences, related or unrelated to the course content, attitude and motivation regarding the course, student dynamics within the class, and the confidence to realize that they can learn the material. Another important factor to consider when introducing new policies and procedures aimed at a group of participants is that there should be equal opportunities for all students to benefit from the process. The following five classifications of instructional strategies that Tanner (2013) proposes are generalizations of the specific practices that faculty members utilize, but they explain the functional rationale for implementing active learning. They include (1) giving students opportunities to think and talk about the course content, (2) encouraging and managing the participation of all students, (3) building an inclusive classroom community, (4) monitoring class behavior to cultivate divergent thinking, and (5) maintaining an environment of learning (Tanner, 2013). It is also important to recognize that active learning practices are designed to keep the student engaged and involved in the learning process (Konopka, 2015).

Student-centered instructional approaches can entail any classroom method that leads the learner to the rational basis of a conceptual change in their existing conceptions, often by revealing incongruities in the student's initial conceptions (Posner et al., 1982). To accomplish this, Posner recommends that teachers develop classroom practices that create conflict in student preconceptions by identifying them and using strategies that reduce barriers to conceptual accommodation, allowing for the introduction of new ideas. In addition, Posner (1982) suggests presenting new concepts in multiple modalities and using various assessment modes to track changes to conceptual modifications (see also

NRC, 1999a). In the NRC report entitled *How People Learn* (NRC, 1999a), instructional skills that enhance learning include identifying pre-existing student understandings, using this information to begin the formation of new knowledge, and recognizing conceptual changes as they take place. Therefore, when teachers create opportunities for students to think and assess their knowledge, while exposing and building on their preconceptions to cultivate new knowledge, this creates an environment of active knowledge construction (NRC, 1999a). An effective teacher will have a strong knowledge base to focus on in-depth content matter, which will allow students to form deep meanings, instead of superficial rote memorization, and to design assessments to identify the newly constructed knowledge. Finally, teachers must develop strategies for expressing learning goals and monitoring student knowledge construction by incorporating metacognitive practices, which help students follow their own learning progression (NRC, 1999a).

Chi (2009) describes the active-constructive-interactive framework for learning around the same ideas about using a person's prior conceptions to repair, build, enhance, and share the new constructions from the learning exercise. According to Chi (2009), this process involves making judgments or drawing conclusions by dynamically sharing ideas with others and building on initial beliefs to create a novel conception that would not have occurred in isolation. Students can be instructed to follow a set of directions to complete an experiment, which reinforces the knowledge base, but without the ability to leap to metacognitive learning, the students will continue to compartmentalize knowledge without being able to integrate the disparate parts and transform their understanding. It is important for educators to understand and challenge the preconceptions that students

have by asking them to test the limits of those conceptions (NRC, 2005). The following examples reflect many of the specific teaching strategies within these five groups.

Knight and Wood (2005) demonstrated active learning by redesigning a developmental biology course which included answering conceptual questions using student responses (via clickers), in-class group discussions, analyses of journal articles, and group collaboration on assignments during labs. Knight and Wood evaluated student success by using a pretest at the beginning of the semester and then embedding the same questions as a posttest in the final exam. They also deployed formative assessments during the semester to gather students' impressions of the learning environment and compare the final grades with a control class section. Their results show that students in the active learning classes performed better than those in the control class that received lectures without active instruction, although the gains were only seen for the students achieving As and Bs, but not those achieving Cs; they suggest that the students who achieved Cs had a more difficult time with the active learning environment and could not benefit from it (Knight & Wood, 2005). In a similarly designed physics class, Beichner and Saul (2001) report student gains with respect to overall grade and student attitudes toward active learning by completing question sets in groups and performing laboratory experiments in groups. Of interest, Beichner and Saul (2001) also note that students from the traditional lecture physics class performed better than the students in the active learning class on problem sets that were more geared toward the lower scale of Bloom's taxonomy. Birol (2017) identifies a positive correlation between class size and time spent lecturing, as both of these preceding examples are of high-enrollment biology and

physics courses, respectively, with more than 50 students per class section. It is reasonable to suggest that active learning practices in high-enrollment courses could increase student retention and completion (Birol, 2017).

Process Oriented Guided Inquiry Learning (POGIL) is another example of student-centered instruction that develops critical thinking, problem-solving, and interaction skills by using small student groups to review data, answer guided questions, and construct conclusions (Farrell et al., 1999). During a POGIL exercise, the instructor is considered to be a facilitator, guiding students where and how to find the answers, not providing the answers to them. In a general biology course for undergraduate science majors, Gonzalez reports on a six-year-long study incorporating POGIL-like practices and comparing the students' successes with the results from the same course offered in a hybrid or an on-campus lecture format incorporating more traditional instructional approaches, but omitting the POGIL material (Gonzalez, 2014). Unlike the aforementioned general biology class, with about 25 students per section, some undergraduate science classes in many colleges and universities typically have 50 to more than 100 students per section. This makes POGIL difficult to incorporate simply due to the logistics of using a large lecture hall, where the seats and tables are anchored and immobile. The consequences of using such facilities are that forming student groups becomes cumbersome, distributing or generating the data/results is time consuming or not possible, especially when the evidence is obtained through laboratory experimentation, and the instructor has difficulty roaming the classroom to assist students. The environmental health course that Jin and Beirma (2013) describe is a high-enrollment

general education course offered in a large, lecture-style room, attended by mostly non-science majors. The obstacles described above are alleviated by the use of clickers, shortening the POGIL sessions, and distributing the data sets electronically (Jin & Beirma, 2013). In both these examples of guided inquiry (Gonzalez, 2014; Jin, 2013), there is evidence that student performance appreciably improved compared to the success rates of classes taught more traditionally, without the use of POGIL.

An alternative instructional practice is implementing the flipped classroom, whereby students are coached on how to study and use the textbook, complete problem sets and answer conceptual problems, and reflect on material in need of further explanation. The students are responsible for reviewing the course material before class, typically by viewing videos replacing the lecture of the day. The instructor's role is to provide supporting information on the difficult content areas, possibly make a short presentation, assign worksheets, show a video/animation, or provide other means of support that build on the student's base knowledge (Entezari & Javdan, 2016; Rau et al., 2017). A modified version of the flipped classroom is the "learn before lecture" approach described by Moravec (2010), in which students complete a pre-class assignment related to knowledge-level material, such as describing the structure and function of a biological part, and then complete an in-class activity applying the knowledge. In all three examples of the flipped classroom in general chemistry, human anatomy and physiology, and biology courses, student outcomes were significantly higher compared to a traditional class environment.

Brown et al. (2014) use the term *interteaching* to describe a method of self-directed learning that includes guided instruction, where students work in groups using study/prep guides, peer interactions and the instructor or tutor to provide feedback, along with lectures that support the engagement session. The *interteach* method resembles the flipped classroom, as students are provided with the prep guides in advance of the class period to review material, except that the guides contain questions that are the focus of the in-class group activities. Additionally, students are discouraged and sometimes limited from using course resources, as peer interaction is desirable (Brown et al., 2014). Byrne and Guy (2016) observe the student outcomes of first-year health sciences students and second-year medical students in a physiology course incorporating *interteaching* as the primary instructional model. The results of the first unit assessment showed that the second-year students performed better than the first-year students, but by the third unit assessment, the first-year students' performance steadily improved to reach the same level as the second-year medical students. The authors attribute this result to the second-year students' prior physiology knowledge and improved study skills, thus demonstrating increased knowledge construction due to *interteaching* (Byrne & Guy, 2016).

Aside from the various instructional practices described above, many variations and novel techniques for engaging students exist to increase student comprehension and program completion, such as using clay to model anatomical structures (Haspel, 2014); playing virtual reality games for understanding physics (Jagoda et al., 2015); conducting undergraduate research in biology (Olimpo, 2016); problem-based learning (Chin, 2006); using dance and movement to understand the electrocardiogram (Schultz, 2009); and case

studies (Carloye, 2017). A review of the benefits and methods employed in science courses can be found in Freeman (2014), Allen and Tanner (2005), Konopka (2015), Beichner and Saul (2001), Henderson (2011), and Tanner (2013). At face value, it would appear that student-centered instructional practices have been ongoing in science courses for some time, albeit with varying rates of success, at two-year and four-year colleges and universities. Considering the positive relationship between student-centered instruction and student outcomes, it would be naive to presume that the faculty implements various teaching innovations without any training on the precise methods and tools involved, knowledge of student backgrounds and learning, or other variables that might hinder the correct execution of the teaching strategy. The implementation of effective instructional skills and utilization of classroom technology involve the PD of faculty.

2.3 Professional Development in Higher Education

According to Henderson et al. (2011), three distinct groups of researchers study pedagogical methods and how to improve them: faculty development researchers, discipline-based education researchers, and higher education researchers. The faculty development researchers provide all faculty members with training in areas of pedagogical skills, motivation, self-improvement, and technology. This institutional group is called the "change agent," a collection of people with knowledge of pedagogy, technology, and class planning, who encourage faculty members to transform their instruction by offering printed materials, presentations, or workshops on practices that have resulted in improved student outcomes (Henderson et al., 2011). One reason for the

continued monitoring and recommendations for improvement is due to the continued development of innovations in instructional technologies, expanded knowledge from cognitive research on how people learn, and changes in institutional and faculty culture on the importance of assessment and program evaluation (Cross, 1986).

PD, as described by Guskey (2002), is a "systematic effort to bring about change in classroom practices" by transforming teacher "attitudes and beliefs" to improve student outcomes. According to Guskey (1986), the PD activities would transform classroom practices, leading to a change in student outcomes, which the faculty would conclude as being beneficial PD and therefore alter their beliefs and attitudes toward the PD. The introduction and development of PD programs in community colleges was due, in part, to an awareness that two-year colleges needed to adjust their instruction to cope with the increasing numbers of diverse, non-traditional, and underprepared students, as Watts (2002) and Gaff and Justice (1978) explain. In the mid-to-late 20th century, PD programs had not been integrated completely into the community college fabric, as evidenced by the barely observable intended benefits, and this was partly from a lack of true institutionalization of the program and concomitant offerings, which could be described as a disparate set of activities (Murray, 2002). According to an Ohio state-wide study of two-year colleges, PD programs were lacking a clear mission and offered faculty unfocused training options. This situation was attributed, in part, to the lack of faculty input and ownership due to the administration's ambivalence as to how to help faculty members become effective instructors (Murray, 1995). A comprehensive PD program

creates didactics centered on the college mission statement and evaluates how well the program offerings satisfy the instructional needs (Watts, 2002).

PD programs have evolved over the past 50 years. This is mainly due to three factors: the spawn of new classroom technologies (or ancillary materials accessed by computer), a change in the culture of post-secondary institutions to accept that cognitive psychology research has identified the dynamic nature of how students learn, and decades of evaluation research showing that teachers do make a difference in the educational process (Olson et al., 2012). As noted in Wilkerson and Irby's (1998) review, the definition of good teaching skills has been transformed by the introduction of cognitive and social learning theories developed in the 1980s and 1990s, respectively; however, the one element that has been germane for many decades is the instructional practice of keeping students motivated and engaged, and giving them the opportunity to learn by investigation. As Guskey (1994) points out, the research on effective PD is often confusing and contradictory, leaving the institution and its professional developers perplexed about what program activities to implement. When determining what PD strategies to include in developing the program, it is important to realize that some components should be teacher-specific and others organization-specific, although the combination of options for the program will be designed according to the particular institutional context (Guskey, 1994).

2.4 Science Professional Development in Higher Education

PD programs focused on science pedagogy, as Hutchins et al. (2008) describe, engage the teacher participants in active learning, combine science content with science teaching, conduct assessments of participant learning, and maintain an environment of collaboration and sustained support. The focal points for these programs came from an evaluation of 47 PD programs in the Missouri K–12 system. A PD program geared for the science faculty should include experiences that are science-focused, improving the instructor's ability to present content that is relevant and engaging to the participant, with the sense that classroom implementation will be supported by the program developers. Paulsen and Feldman (1995) suggest that PD programs should stimulate three phases of faculty change in order for instructional practices to lead to improved student learning. The first phase of faculty change comes from "unfreezing" faculty members' beliefs about their present behaviors and the results being generated. If a teacher realizes that their instructional methods are not producing the results they anticipated, they are likely to accept new knowledge to transform their practices (Paulsen & Feldman, 1995). The second phase of change arises from a cognitive redevelopment of the instructors' beliefs and behaviors. This is the stage when information about new methodologies is gathered and assessed to determine compatibility with the desired goals, and, assimilated into any remaining beliefs. The third stage of change is called "refreezing," as the new beliefs will be cognitively incorporated and presented as new instructional behaviors that transform the learning environment and lead to the desired outcomes (Paulsen & Feldman, 1995).

Of course, as an iterative process, this cycle of belief and behavior reconstruction will be ongoing and, over time, should lead to high-quality instruction.

In an extensive review of PD programs and activities, Bouwma-Gearhart (2012) identifies requirements for postsecondary faculty development similar to the K–12 characteristics identified by Hutchins (2008). Other characteristics that Bouwma-Gearhart takes into consideration in the review are that the PD program for science faculty should be challenging and centered on individual faculty needs and strengths. Bouwma-Gearhart also argues that teachers should reflect on the successes and learning outcomes after implementing new instructional practices. Avery and Reeve (2013) point out that the success of an engineering PD program has two components: the PD developers consider the faculty participants' ideas and concerns and they provide the needed support to sustain the pedagogical knowledge obtained from the program.

PD developers believe that the faculty will incorporate a particular instructional practice on the basis of empirical data showing increases in student outcomes. In reality, if the instructional activity takes longer to integrate than the faculty members believe it should take, the result will not always lead to wider acceptance or implementation (Fisher et al., 2005). It has been noted that faculty beliefs and behaviors about their academic purpose vary by discipline. At research universities, faculty promotions and tenure are awarded for scholarly progress more than teaching (Fairweather & Paulson, 2008). At community colleges, where instruction is the primary function of the faculty, no merit system exists when faculty members exhibit excellence in their teaching (Fairweather & Paulson, 2008). Irrespective of academic discipline, faculty members who implement

active and collaborative teaching strategies increase student success (Fairweather, 2008), yet most introductory courses rely primarily on class lectures with a "lecturer" addressing a passive audience and laboratory exercises requiring students to follow a prescribed recipe of directions (Handelsman et al., 2004).

The PD program that Henderson (2008) describes is intended for new tenure-track physics and astronomy faculty members. The "workshop" is a four-day program that presents information about the latest physics and astronomy education research materials and pedagogies. Some of the unique characteristics of this program are that only new faculty members from the physics and astronomy fields are invited to attend, and the pedagogical topics are diverse to appeal to all faculty needs. There are both small and large group sessions covering many topics including student retention, assessment, active/interactive learning strategies, problem-solving, and implementing research into practice in the classroom. Henderson (2008) cautions that using self-reported data on classroom implementation of student-centered instructional practices runs the risk of over-estimating their usage. This suggests that a program evaluation should be aimed at gathering data that provides unambiguous evidence of program effectiveness.

Avery and Reeve (2013) endorse a subject-matter-rich PD program that will allow faculty to give undergraduate students a deeper understanding of the course content by familiarizing them with the discipline as if they were conducting research themselves. Their recommendations are that an effective engineering PD program should include an environment of faculty contribution and program ownership, a design model that encourages developing problem-solving skills with real-world implications, and the

initiation and maintenance of the integration of the instructional materials in the classroom setting. In a more informal and small-scale program, Fisher (2005) describes the reinvention of a course for undergraduates in electrical engineering, where faculty and department heads collaborated to streamline the course objectives and introduce active learning practices. Fisher compares data from student self-reported learning outcomes regarding the modified course and traditional course, and then detects improvements in the modified course. In this case, the faculty did not attend formal PD training, but used information from several published reports claiming student gains in engineering skills after mastering the prescribed instructional methods (Fisher, 2005). The examples presented all have one important trait to underscore: they are all assessed in some way to determine the efficacy of the program**.** Program evaluation indicates whether instructional practices are successfully engaging students and creating a constructivist environment for learning, which is the recommended context for science education (NRC, 2012).

While it may appear that progressive PD is ongoing in two- and four-year colleges, Derting (2016) and Ebert-May (2015) note that reliable empirical evidence does not exist to indicate that faculty members implement what they learn about PD in the classroom. If there is to be a transition in the culture of instruction to student-centered learning practices, there needs to be a fundamental change in how faculty members perceive their role as educators (Ebert-May, 2015). Many have argued that a required component for a conceptual shift in educational practices arises from faculty members changing their beliefs about how students learn and how they teach (Guskey, 2000; Ho,

2001). According to Derting's (2016) argument, improvements to the PD program cannot be made unless the impact of the PD training on teacher behavior is assessed, and self-reported data are not consistent with observed classroom instruction. It is to the benefit of stakeholders (students, faculty, PD staff, and administrators) to recognize which PD activities make a valuable impact on teaching practices and learning outcomes. It is with this goal in mind that the PD evaluation at DTCC starts with an evaluation of faculty self-reported needs and classroom practices.

2.5 Evaluation of Science Professional Development in Higher Education

As Kirkpatrick (1971) describes, the objective of an evaluation is to "accurately appraise the performance of an individual and to help that person improve those areas that need improvement" (p. 22). To understand the extent to which a PD program is successful, Kirkpatrick (1977) advises structuring evaluations into four levels of organization. Foremost, evaluations should start with the participants' level of satisfaction with the training, followed by their level of understanding and knowledge gained from the program, including the measurement of behavioral change due to the development training, and finally what outcomes occurred as a result of the program. Guskey (2002) modifies this list by adding institutional contributions to the program, considering that any development program can only succeed to the level that the college policies permit and that resources must be made available for new instructional practices

to be implemented, such as needed space, personnel, technology, release time, and other factors.

The federal Education Sciences Reform Act (2002) describes a rigorous evaluation, endorsed by several national educational associations and the U.S. Congress, as one that adheres to high standards of quality in design and statistical analysis, expresses the results in relation to the projected effects, gives an accurate description of the program being evaluated, utilizes experimental methods, and uses dependable methods of evaluation (Kucsera & Sviniki, 2010). Fink (2013) explains that PD program evaluations must identify two main categories: (1) the effect on instructional practices, and (2) the result in terms of student outcomes. He further states that the most effective methods of measuring faculty practices and student outcomes are by direct observation and analysis of records, respectively (Fink, 2013).

The evaluation data gathered from PD programs can reflect various metrics of success. A comprehensive review of the literature reveals that only 36 published articles directly evaluate PD programs in higher education designed to target student learning with empirical data (Stes, 2010). Only 21% of these publications demonstrate student impacts by using control or comparison groups, indicating that direct evaluation of PD is still in the early stages and needs more consideration. Many research articles provide evidence of PD success by reviewing student evaluations of teaching or presenting questionnaire results that reveal self-reported benefits for faculty, such as changing perceptions or conceptions of instruction, use of new instructional practices, or observed

benefits to students. Kirkpatrick (1977) argues that evidence of success is not proof of success, and Ebert-May (2011) and Stes (2010) point out that while some studies have shown an increased use of student-centered instruction through faculty self-reporting, an independent assessment of classroom behavior and effects on student success is needed.

There have been some evaluations of PD programs, and they often indicate that the faculty implements or modifies the new instructional methods in a teacher-centered mode or simply rejects that the new practice is of any benefit (Biggs, 1996; Trigwell, 1996; Wilson & Corbett, 1990; Cohen & Ball, 1990). In a study on K–12 science teachers, Supovitz (2000) uses data from a survey whereby teachers self-reported the implementation of inquiry-based instructional methods to conclude that the Local Systemic Initiative PD program was generating increased active-learning instructional practices in the classroom. He also notes that teachers with a higher level of content preparation and a greater willingness to accept new instructional strategies self-reported increased use of student-centered instruction (Supovitz, 2000). In a larger scale evaluation of 40 different PD programs for K–12 teachers across Australia, Ingvarson et al. (2000) used a survey instrument to measure the impact that training had on the process of learning, teacher knowledge, classroom practices, and student outcomes. Again, teachers self-reported the increased use of active learning strategies and improved student outcomes, although the study did not measure student assessment scores. Moreover, according to an evaluation of a PD program for community college science faculty, when the faculty had strong positive beliefs about the benefit of a learner-centered laboratory

strategy, students gave positive ratings for the practice and the faculty worked to expand its utilization throughout the course (Hutchins, 2012).

To evaluate a PD program at a Hong Kong university, Ho (2001) used faculty and student surveys as well as faculty interviews to conclude that when faculty conceptions of teaching changed to more student-centered values, students reported study habits that mirrored cognitive learning. The evaluation of an undergraduate engineering course redesign by Fisher (2005) found that students self-reported an increase in active-learning instructional strategies and learning outcomes as a consequence of participating in the engineering course redesigned with more active learning methods. Roehrig et al. (2012) evaluated the BrainU PD program to integrate a learner-centered neuroscience module in K–12 classes and record increased cognitive learning with an increase in active learning practices, as described by direct classroom observation compared to control classrooms. Thus, surveys and observational data are common features of a PD program evaluation.

Using a more direct evaluation method to assess a national PD program for science faculty from two- and four-year institutions, Ebert-May and colleagues (2011) employed a combination of faculty surveys and classroom observations to measure the use of active-learning instructional techniques in an introductory biology course. The results demonstrated that most faculty members overestimated their use of student-centered learning practices after participating in the development program, as direct observation of their teaching methods before and after training did not show any significant difference. In a follow-up evaluation of a restructured PD program for science

post-doctoral faculty, Ebert-May et al. (2015) found direct correlations between faculty self-reported use of student-centered pedagogy and observed in-class practices, although they did not find that the transition to a constructivist pedagogy manifested in the use of higher order Bloom's taxonomy assessments. Of additional interest, Derting (2016) re-evaluates the pedagogical gains made by the post-doctoral faculty in the Ebert-May (2015) study to determine the sustainability of their PD. A subset of post-doctoral faculty members, who had obtained faculty positions, agreed to participate in the evaluation, completed a survey and permitted direct classroom observation. Those who completed the PD program showed significantly more student-centered instructional activities compared to a control group that did not complete the training, on average, two years after participating in the PD program (Ebert-May, 2015).

The preceding PD program evaluations were aimed at identifying the types of learner-centered instructional methods used and the extent of their implementation in the classroom. The program developers designed the program topics and activities according to research-driven data on effective student-centered pedagogy, but faculty were not widely adopting these practices (Biggs, 1996; Trigwell, 1996). Many of the aforementioned studies reveal that faculty self-reporting is not an accurate indicator of pedagogical use (Fisher, 2005; Ebert-May, 2011, 2015), and Ho (2001) maintains that a possible reason for this is that faculty do not believe that changing their classroom behaviors will translate into a cognitive change for students. Nevertheless, Hativa (1993) reports that university science faculty from chemistry, physics, and mathematics disciplines believe that the primary goals of teaching are to encourage students to think

independently and teach problem-solving skills to stimulate interest in continuing academic progression in the field. Birol (2017) finds a negative correlation between class size and faculty self-reported use of student-centered instruction after surveying almost 1,200 faculty members from all academic disciplines. Furthermore, Lindblom-Ylanne (2006) observes that faculty in the pure and applied disciplines, such as chemistry, biology, medicine, and physics, were more likely to use teacher-centered pedagogy, but that changes in pedagogy occurred when faculty perceptions of teaching and learning changed.

Marbach-Ad et al. (2014) found that changes to instructional practices arise from PD activities that transform faculty beliefs in the benefits of student-centered learning combined with a collegial atmosphere that supports and affirms long-term change. They evaluated the effects of participating in a PD program with a faculty learning community on biology and chemistry faculty beliefs and instructional practices. They surveyed biology and chemistry faculty and undergraduate seniors in those departments at the University of Maryland using several metrics to provide information about faculty beliefs, instructional practices, and faculty learning community engagement. Marbach-Ad et al. (2014) reported that science faculty and undergraduate students rated many of the important skills for science students to acquire at similar levels; however, students considered rote memorization of facts and formulae as an important skill, while faculty rated memorization at a lower level.

Marbach-Ad et al. (2014) also found that faculty gave high ratings for the importance of using student-centered teaching methods recognized by national reports, such as NRC (1999a) and NRC (2005). Science faculty participating in PD activities and belonging to a faculty learning community rated the importance of relating content to scientific research and historical perspectives, using various teaching methods and assessments, and using ungraded assessments significantly higher than faculty only participating in PD activities. Faculty reported using extensive lecturing as one of their top five instructional methods along with answering individual student questions, engaging students in class discussions, and presenting graphical information to interpret. University science faculty and physiology students concur that using student-centered, active-learning classroom strategies promotes student achievement, yet, the science faculty self-report the limited use of those methods (Lorelei et al., 2016). These results are consistent with undergraduate students' reporting of lecturing as the second highest ranked form of instruction during their science education. It is with these findings in mind that this survey project was carried out to elucidate whether science faculty are implementing student-centered instructional practices after participating in the PD training opportunities provided at DTCC and what, if any, improvements would address the discipline-specific needs.

2.6 The Power of Learning Communities

Marbach-Ad et al. (2014) report that faculty belonging to a teaching and learning community rated learner-centered teaching practices as having greater importance than

faculty not participating in a community. This result raises the question of whether a faculty learning community would enhance the teaching behaviors of faculty to increase the use of active learning pedagogy. In fact, Marbach-Ad et al. (2014) indicate that faculty associated with a learning community reported using teacher-centered instructional methods significantly more than faculty not belonging to a community. However, the effects of the faculty learning community on instructional practices and student outcomes were not elucidated. This avenue of inquiry is important for academic institutions, since peer learning communities have shown promise in helping students succeed in college (Scott, 2017).

Blaisdell and Cox (2004) underscore that opportunities for collegial discussions on pedagogy are rare, and they go on to describe a faculty learning community for mid-career and senior faculty. This learning community helps faculty discover new "directions" in teaching by enabling members to share with each other what they do. As Cox (2004) explains in his review of learning communities, Dewey, in 1933, first introduced the formation of student learning communities to remedy the lack of student engagement in classrooms. The benefits of student learning communities have been well-documented since their mainstream establishment in the 1980s, but institutions have also experienced several challenges with respect to class scheduling, structuring a faculty reward system for team teaching, and cross-discipline teaching (Cox, 2004). In a discipline-based faculty learning community, Hubball et al. (2004) describe a metacognitive approach that merges the development of both content knowledge and instructional skills of learning how to learn or metacognition. As metacognitive skills

proliferate and differentiate within the learning community, professional developers can emphasize developing pedagogy while the faculty members enhance their content knowledge.

As an example of a successful discipline-based faculty learning community (FLC), Elliot (2016) reports that an eight-member learning community of biology faculty members worked together to transform the pedagogy in a second semester undergraduate biology class toward more active learning. With biweekly meetings, the faculty group reviewed the literature, investigated instructional technology and resources, and shared their classroom situations to iteratively build an engaging course. Students exposed to active learning instruction performed significantly better than the lecture-only control class, with varying degrees of grade increases with respect to unit assessments (higher gains for biological membranes, lower gains for genetics) (Elliot et al., 2016). Of additional importance, faculty members expressed satisfaction with the FLC process and with the gains in student outcomes, rating the inclusion of student-centered instruction as helpful or very helpful to their pedagogical practice. In a similar study conducted by Auerbach (2017), student outcomes increased as faculty devoted more class time to active learning exercises. Apart from reviewing student grade records, class observations were conducted over a three-year period to create an iterative process of improvement during faculty meetings, and a congruent relationship was shown between reported use and observed use of active learning instruction in the introductory biology class (Auerbach, 2017). In both these examples, the learning community was focused on one discipline and, in particular, one course, but as Cox (2004) points out, a learning

community can stimulate faculty interest in undergraduate pedagogy, encourage collaboration between faculty from different disciplines, and nurture the development of new curricula. Faurer (2014) and Tovar (2015) identify FLCs as suitable mentoring programs to help new faculty transition to the college culture and promote confidence in teaching to pursue novel pedagogical practices.

An academic institution should consider several factors before establishing an FLC. Shulman (2004) outlines five elements that administrators should address in order to determine what levels of fidelity and proficiency the FLC will attain. An important aspect of implementing an FLC is demonstrating an instructional need and identifying the need as an effort for improvement, not for repairing a deficiency. This will encourage faculty buy-in and stimulate interest without mandating participation (Shulman, 2004). The next aspect is ensuring that the FLC developers (and advocates) have the essential characteristics to drive participation and program validity. Shulman (2004) suggests that the FLC developers have a high rank, be considered as experts with diverse backgrounds, have a reputation for delivering quality instruction, and be competent to design, execute, and maintain the program. The following two points to consider are intended to ensure that the FLC program has a persuasive vision statement that can be effectively disseminated. First, the vision statement, designed by multiple, interested stakeholders, must focus on attracting faculty participation by appealing to faculty desires to improve teaching and learning practice and by effectively communicating the statement to the institution's personnel (Shulman, 2004). Second, a carefully designed, integrated, and maintained FLC can benefit faculty in all disciplines and with all experience levels.

Chapter 3

METHODOLOGY

3.1 Purpose

The purpose of this executive position paper is to elucidate the perceptions that science faculty have about student-centered instruction, if science faculty are implementing student-centered approaches in the classroom, and what PD opportunities might benefit science faculty practices. Identifying the PD needs of science faculty, and providing the effective PD curriculum to address those needs, fosters a learning environment that directly impacts student outcomes, retention, and graduation rates of allied health and nursing students at the college. Furthermore, a student-centered learning environment has been shown to increase cognitive learning (Konopka, 2015) and better prepare students for STEM studies (AAAS, 2010).

3.2 Executive Position Paper Questions

In order to better understand the impact of the college's current professional development efforts, I surveyed our current science chairs, faculty, and CCIT staff.

Key Question 1: What do science faculty, CCIT staff, and department chairs (DCs) believe are the most important skills for science students to acquire? Do these beliefs differ between groups?

Key Question 2: What instructional practices do faculty, CCIT staff, and DCs believe are important for achieving student-centered learning? Do these beliefs differ between groups?

Key Question 3: What instructional practices do faculty members report using in their classes most often? Does the reported use of instructional practices by faculty differ from what DCs report during classroom observations or the importance identified by DCs and CCIT staff?

Key Question 4: Does CCIT offer training in any of the instructional practices faculty identify as important for student-centered instruction?

Key Question 5: What types of assessments do the science faculty use in their courses? Do the assessments used in the science courses reflect student-centered learning outcomes?

Key Question 6: What perceptions do science faculty, CCIT staff, and DCs have of the different types of training opportunities offered by the CCIT?

3.3 Study Instruments

3.3.1 Surveys

Data were obtained from a survey sent to three college populations: all science faculty at three of the four campuses (the investigator's campus was excluded because college policy prohibits research data collection from subordinate employees), all CCIT staff, and the science department heads at the three campuses. Each survey instrument was generated by using a modified version of the faculty survey from Marbach-Ad et al. (2014). Additionally, some questions were streamlined by grouping answers relating to similar classroom procedures. For example, in-class activities included reflective writing, journaling, graphic organizers, data interpretation, and a student response system. Some questions about the PD offerings included specific items about the NFD program or CCIT. Lastly, some questions were modified to reflect the precise organizational characteristics of the PD program at DTCC—specifically, the identification of the NFD program for newly hired faculty. See Appendix A for a review of the faculty survey.

The faculty survey was modified for this study by excluding questions or question components that related to faculty learning communities, gender, and academic rank. Questions about PD were centered on the NFD program and the training topics offered by the CCIT. The question asking respondents to describe their teaching philosophy was omitted along with questions on campus professional or course communities. Some components of the question on important skills for undergraduate students were deleted, such as decision-making skills, information literacy, creativity and innovation, and

qualitative reasoning, to keep the survey length manageable. Extensive lecturing was described as more than 45 minutes before taking a break for a class activity or answering questions. The types of courses instructors taught included an elective choice to represent those courses that were not prerequisites or core choices to enter a program but, instead, to complete their program with the minimum required science credits.

The DC survey included a question about the frequency of instructor observation and the instructional strategies observed by the faculty. There was also a question asking for a subjective conclusion about the type of instruction observed—that is, whether it was mostly lecturing, a combination of lectures and active learning, or mostly student-centered instruction. Finally, DCs were asked to identify the skills that are important for science students.

The CCIT staff survey included a question about what skills science students needed to gain and which assessment methods encouraged student-centered learning. There was also a question about the types of instructional practices that promote active learning and whether CCIT offered these practices, along with assessment methods, as training sessions.

3.3.2 Population description

3.3.2.1 Faculty

Thirty-three faculty members were sent surveys at three of the four campuses. Fifteen surveys were completed after three reminders at two-week intervals. Faculty at

the Terry Campus were not sent surveys because of the college policy prohibiting a supervisor from collecting data from subordinates. Eight faculty respondents had gained teaching experience prior to employment at DTCC, and eleven faculty had three years or less of teaching experience. Nine of the faculty respondents had been at the college for less than 10 years. All but two faculty respondents were regular instructional faculty, with two also having instructional coordinator duties. On a scale from 1 to 9, with 9 being the most satisfied, all faculty respondents were satisfied with teaching with a minimum satisfaction value of 7.

3.3.2.2 CCIT staff

Twenty CCIT staff were sent surveys at all four campuses. Twelve surveys were completed after three reminders were sent at two-week intervals. Only five of CCIT staff had prior teaching experience, and all five reported between four and six years of teaching experience prior to employment at DTCC.

3.3.2.3 Science department chairs

All three DCs responded to the survey. Two of them had been at the college for more than 10 years and two of the three had no prior teaching experience before arriving at DTCC. The EPP author is a science DC, but was excluded from participating in the survey pursuant to the college's conflict of interest policy.

Chapter 4

RESULTS

4.1 Key Question 1

What do science faculty, CCIT staff, and DCs believe are the most important skills for science students to acquire? Do these beliefs differ between groups?

Surveys were sent to science faculty, CCIT staff, and science DCs to rate the importance of several educational skills on a scale from 1 to 5, where 1 = not important and 5 = very important. Table 1 shows the results of the survey (as percentiles) for the importance of various skills, combining the categories of important (category 4) and very important (category 5).

There was consistency among the three populations in terms of identifying important or very important skills that science students should possess. Faculty (80%), CCIT staff (90%), and DCs (100%) found scientific writing to be important or very important. The following other skills were rated as being important or very important: acquiring major scientific concepts (faculty = 100%, CCIT staff = 100%, DCs = 100%), understanding the dynamic nature of science (faculty = 93%, CCIT staff = 91%, DCs = 100%), and understanding how science relates to everyday life (faculty = 93%, CCIT staff = 90%, DCs = 100%) (Table 1).

Faculty ratings were compared to CCIT staff and DCs ratings of important skills science students should have using the Independent Samples T-test. The results show that science faculty (87%) rated memorizing basic scientific facts higher than DCs (67%) and CCIT staff (70%), whereas DCs (100%) rated remembering formulas, structures and procedures much higher than CCIT staff (67%) and faculty (67%) (Table 1). There was no significant difference between groups at $p = 0.05$, suggesting that any one group did not rate these skills more importantly than the other groups.

Table 1.
Science Faculty, Science Department Chairs, and CCIT Staff Ratings of the Importance of Skills for Science Students.

	Percentage rating skill as important or very important			*Importance score M (SD)*		
Skills for science students	**Science faculty**	**CCIT staff**	**Dept. chairs**	**Science faculty**	**CCIT staff**	**Dept. chairs**
Scientific writing	80%	90%	100%	3.13 (0.57)	3.10 (0.74)	3.33 (0.58)
Memorize some basic facts	87%	70%	67%	3.07 (0.97)	2.80 (0.60)	3.33 (1.15)
Acquire major scientific concepts	100%	100%	100%	3.80 (0.41)	3.50 (1.72)	4.00 (0.00)
Learn basic sets of laboratory skills	93%	100%	73%	3.53 (0.80)	3.09 (0.80)	4.00 (0.00)
Understand the dynamic nature of science	93%	100%	91%	3.60 (0.63)	3.18 (0.57)	4.00 (0.00)
Understand how science applies to everyday life	93%	100%	90%	3.73 (0.59)	3.40 (0.70)	4.00 (0.00)
Remember formulas, structures, and procedures	67%	100%	67%	2.67 (0.49)	2.67 (1.21)	3.33 (0.58)
Work in groups	53%	NA	NA	3.38 (1.41)	NA	NA

NA - Not applicable, question not answered.

4.2 Key Question 2

What instructional practices do faculty, CCIT staff, and DCs believe are important for achieving student-centered learning? Do these beliefs differ between groups?

CCIT staff and DCs were asked to rate different instructional practices considered to be effective for student-centered learning on a scale from 1 to 4, where 1 = not important and 4 = very important. The results for categories 3 (important) and 4 (very important) were combined for analysis (Table 2A).

CCIT ratings of instructional practices were compared to the DCs' ratings using the Independent Samples T-test. The results show that CCIT staff rated group work during class significantly different compared to the DCs' ratings ($p < .05$). CCIT staff rated using group work more important for student-centered learning compared to DCs' ratings, while all other instructional practices were rated equally by both populations (Table 2A). These results indicate that the difference in importance ratings for group work during class between populations is very unlikely due to chance (Table 2A).

It should be noted that for this project only science DCs were surveyed (n=3), and the results of any statistical test are only suggestive of the science DCs perceptions and cannot be considered conclusive evidence of how science DCs might differ from all DCs. This project will consider the responses from the science DCs specific only to the three respondents and will not attempt to make any generalizations about DCs in other departments.

Table 2A.
Comparison of Science Department Chairs and CCIT Staff Ratings of the Importance of Various Instructional Practices to Student-Centered Learning (Mean Ranking).

	Importance score M (SD)	
Instructional Practices	**CCIT staff**	**Dept. chairs**
Communicating course goals and objectives to students	3.40 (0.70)	4.00 (0.00)
Group work during class time (including discussions, games, simulations, debates)	3.50 (0.53)	2.67 (0.58)
Group work outside of class time (including Wikis, discussion boards, case studies)	3.10 (0.88)	2.33 (0.58)
Extensive lecturing (lecturing for more than 45 min. per class hour)	2.00 (0.94)	2.33 (0.58)
In-class activities (reflective writing, journaling, graphic organizers, data interpretation, clickers)	3.70 (0.48)	3.00 (1.00)
Online modules with immediate feedback (e.g., Mastering, Wiley Plus)	2.80 (0.92)	2.33 (1.53)
Multimedia instruction (e.g., video clips, animations, sound clips)	3.10 (0.57)	3.33 (0.58)

Note: Ratings based on categories 1 (not important) to 4 (very important).

The science faculty, CCIT staff and DCs gave high importance to communicating course goals and objectives, while all three groups gave extensive lecturing low importance (Table 2B). Using the Analysis of Variance (ANOVA) and Tukey's post hoc statistical tests, no significant difference between the groups for either category was observed. Faculty were not surveyed on the other instructional practices seen in Table 2A, and therefore no comparison is included. Instead, science faculty were surveyed on

the extent in which the instructional approaches identified in Table 2A were utilized by faculty (Table 3).

Table 2B.
Comparison of CCIT Staff, Science Department Chairs, and Science Faculty Ratings of the Importance of Two Instructional Practices to Student-Centered Learning. (Mean Ranking)

Instructional Practices	*Importance score M (SD)*		
	CCIT staff	**Dept. chairs**	**Science faculty**
Communicating course goals and objectives to students	3.40 (0.7)	4.00 (0.00)	3.47 (0.52)
Extensive lecturing (lecturing for more than 45 min. per class hour)	2.00 (0.94)	2.33 (0.57)	2.07 (0.70)

Note: Ratings based on categories 1 (not important) to 4 (very important).

CCIT staff and DCs were then asked to pick the top five instructional practices that promote student success in high-enrollment and high-attrition science courses. Figure 2 shows that CCIT staff picked in-class activities (reflective writing, journaling, graphic organizers), engagement activities (clickers, games, role play, discussions), out-of-class activities (discussion boards, Wikis), communicating course goals and objectives, and multimedia instruction (video clips, animations, sound clips) as their top five important instructional practices that promote student success in high-enrollment and high-attrition science courses.

For clarity, due to the small sample of DCs (n = 3), the data show only the top four instructional practices. The DCs picked communicating course goals and objectives, engagement activities, multimedia instruction, and in-class activities as their top four instructional practices in high-enrollment and high-attrition science courses. Of interest, a higher percentage of CCIT staff (80%) picked out-of-class activities as a top 5 instructional practice, compared with DCs (33.3%), to stimulate student learning (Figure 2).

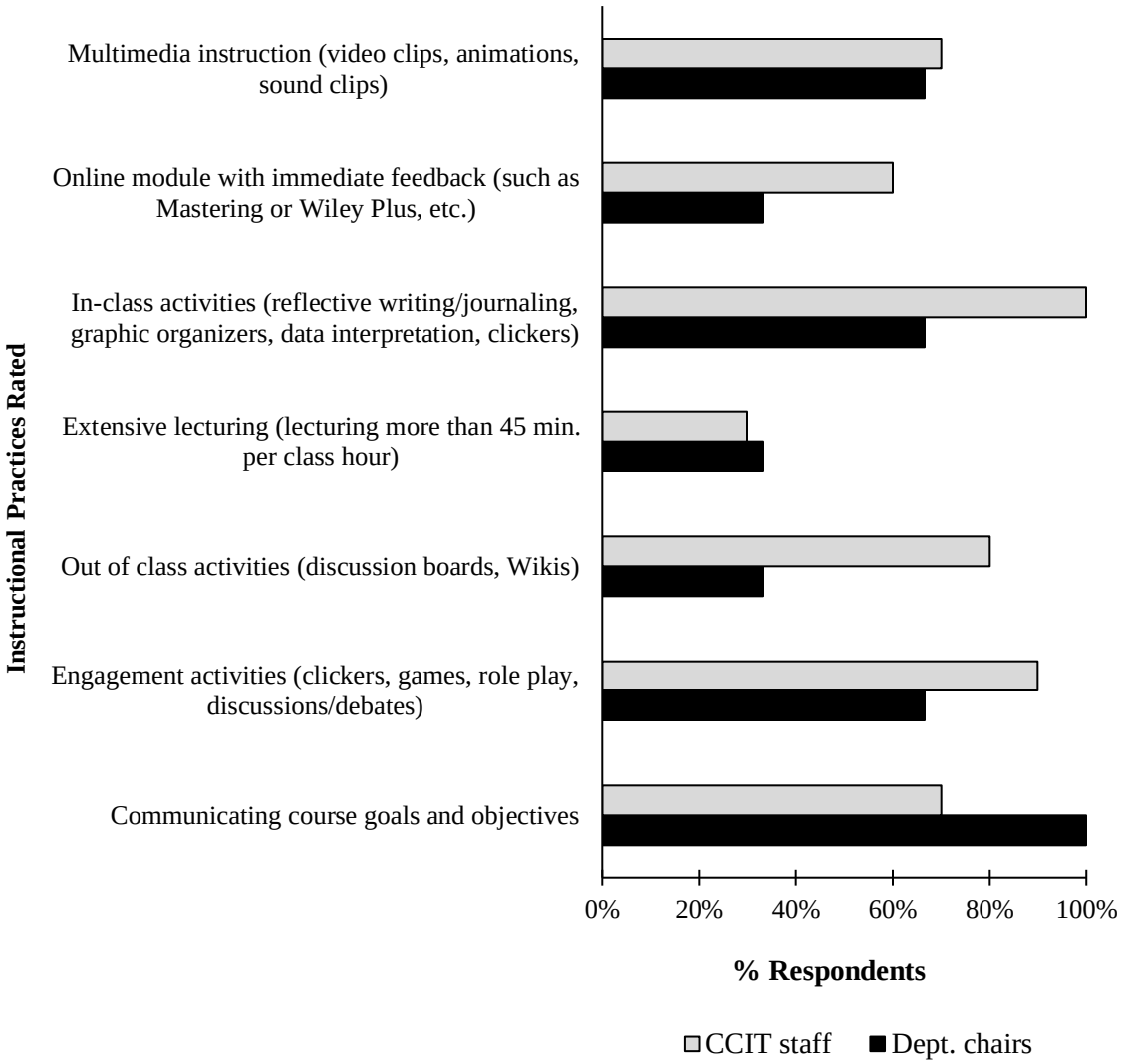


Figure 2. Top Five Instructional Practices that Promote Student Retention in High-Enrollment / High-Attrition Science Courses According to CCIT Staff and Department Chairs.
Note: n= 10 (CCIT staff), n=3 (Dept. chairs).

4.3 Key Question 3

What instructional practices do faculty members report using in class most often? Does their reported use of instructional practices differ from what DCs report during classroom observations or the importance identified by DCs and CCIT staff?

The results in Table 3 show science faculty members' reported use of instructional practices. Forty percent reported using group work during class time in most class sessions, while only one instructor reported using group work outside of class time. Interestingly, CCIT staff rated group work outside of class as one of their top five most important instructional practices for high enrollment/high attrition classes (see Figure 2). This is an engagement strategy used frequently to promote active learning (NRC, 2005).

Almost half of the science faculty (7/15 instructors, 46.7%) reported using multimedia instruction in most class sessions, while the remaining faculty members reported using multimedia instruction in a few class sessions (7/15 instructors, 46.7%) or not at all (1/15 instructors, 6.7%). Further, 33.3% (5/15 instructors) reported using online modules, such as Wiley Plus or Mastering, during every class session and 20% (3/15 instructors) during most class sessions (Table 3). Both CCIT staff and DCs rated multimedia instruction among their top five instructional practices for high-enrollment/high-attrition science courses (see Figure 2).

Four science faculty members (26.2%) reported using in-class student activities in every class session or in most class sessions, while six (40%) reported using extensive

lecturing (more than 45 minutes without a break for questions or activities) in every class session, and five (33.3%) reported this for most class sessions. Cumulatively, 73.3% of the faculty (11/15 instructors) employed extensive lecturing in all or most class sessions (Table 3). The reported use of in-class activities and extensive lecturing is contrary to what faculty, CCIT staff, and DCs stated as being important student-centered instructional practices and beneficial for high-enrollment/high-attrition science courses (see Tables 2A and 2B and Figure 2).

Table 3.
Reported Use of Instructional Practices by Science Faculty.

Instructional Practices	*Percentage of Use Reported*				*Rank Score*
	Every Class	**Most Classes**	**Few / One Class(es)**	**Not at all**	**Mean (SD)**
Communicating course goals and objectives to students	20.0%	53.3%	26.7%	0%	2.93 (0.50)
Group work during class time (including discussions, games, simulations, debates)	0%	40%	53.3%	6.7%	2.33 (0.38)
Group work outside of class time (including Wikis, discussion boards, case studies)	0%	6.7%	26.7	66.7%	1.40 (0.40)
Extensive lecturing (lecturing for more than 45 min. per class hour)	40.0%	33.3%	26.7%	0%	3.13 (0.70)
In-class activities (reflective writing, journaling, graphic organizers, data interpretation, clickers)	6.67%	20.0%	46.7%	26.7%	2.07 (0.78)
Online modules with immediate feedback (e.g., Mastering, Wiley Plus)	13.3%	20.0%	53.3&	13.3%	2.33 (0.81)
Multimedia instruction (e.g., video clips, animations, sound clips)	0%	46.7%	46.7%	6.7%	2.40 (0.40)

Note: Mean Rankings based on categories 1 (Not at all) to 4 (Every class). Percentages are presented for rank 2 as combined categories, few classes and one class.

The data in Figure 3 compare the faculty-reported use of instructional practices with CCIT staff rated importance of the same instructional practices using the Independent Samples T-test. The results in Figure 3 indicate that in all but two items (online modules and communicating course goals) there is a significant difference between the science faculty and CCIT staff respondents. In the rating of extensive

lecturing in high enrollment/high attrition courses, the Independent Samples T-test showed a significant difference between the two populations ($p < 0.01$). This result indicates that faculty are utilizing extensive lecturing more frequently than CCIT staff recommend using in a student-centered classroom environment. A similar significant difference was found between the science faculty reported use of extensive lecturing and the DCs importance rating for extensive lecturing ($p < 0.05$) . Science faculty also reported using group work during class time ($p < 0.01$) and group work outside class time ($p < 0.01$) significantly less than what CCIT staff considered effective instructional practices. Significant differences were also found when comparing faculty-reported use of in-class activities to the rating of CCIT staff ($p < 0.01$) and faculty use ($p < 0.01$) of multimedia instruction compared to the rating of CCIT staff (Figure 3).

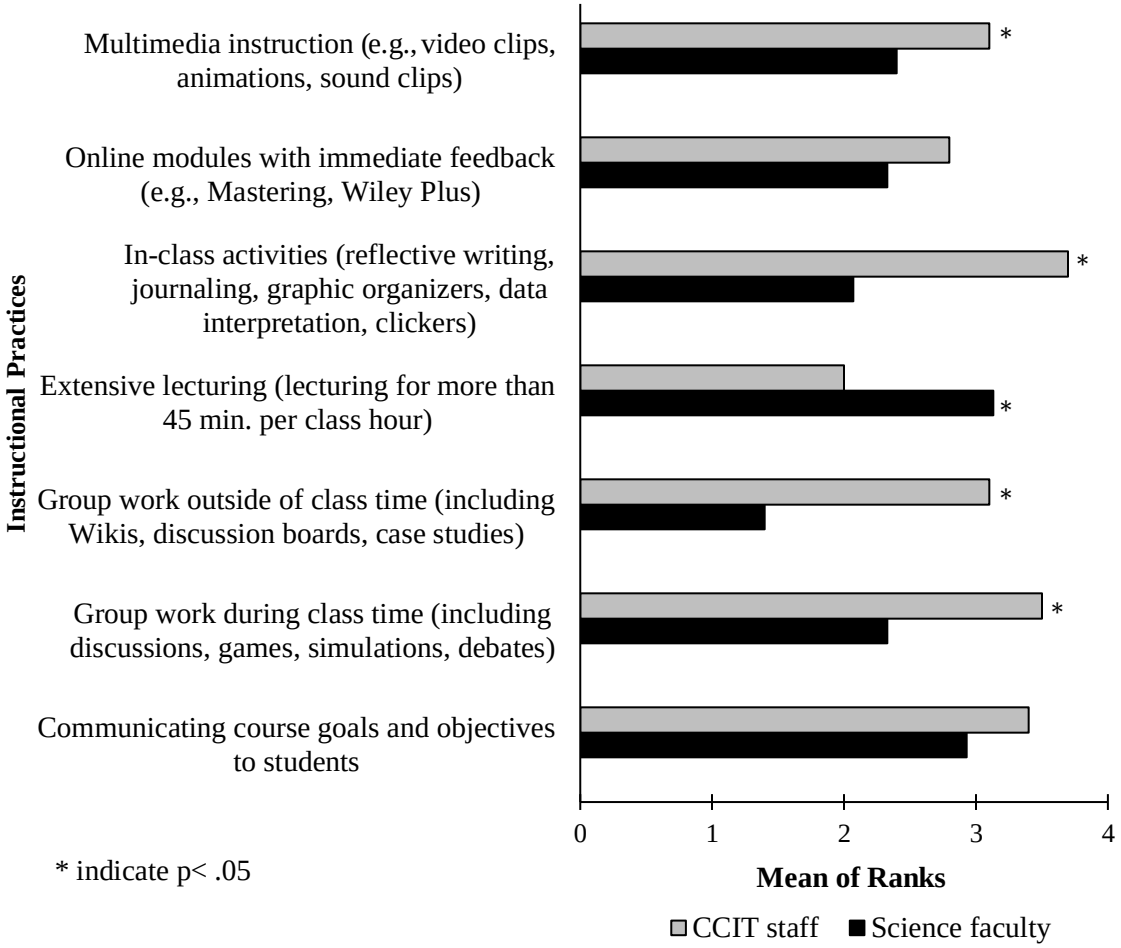


Figure 3. Comparing Instructional Practices Used by Faculty to Those Chosen to Promote Student Success by CCIT in a High Enrollment / High Attrition Science Course (Means of Ranked Scores).

Note: Mean rankings based on categories 1 (Not important / Not at all used) to 4 (Very important / Used every class session)

The data in Figure 4A shows the DCs' ratings of observed instructional practices in the classroom as "used effectively" or "needs improvement". All three (100%) of the DCs rated classroom presentation, lecture organization, lecture content, and student interaction as "used effectively", while student engagement and assessments were rated as "needs improvement" by two of the three DCs (67.7%) (Figure 4A).

Figure 4B shows the various instructional methods the DCs observed in the classroom. All three (100%) DCs observed the use of question creation, cooperative learning/group discussions, simulations, and problem-based/case studies, while only one DC observed the use of data analysis, concept maps or other methods (Figure 4B). The data in Figures 4A and 4B indicate that DCs are observing the science faculty deliver the course lesson using a mixture of learner-centered instructional methods and some lecturing.

Interestingly, the results in Table 3 show that faculty are reporting the use of classroom lecturing as their primary instructional method, yet DCs report observing various student-centered instructional practices, such as problem-based learning and data analysis, in the classroom (Figure 4A and 4B). One explanation for the discrepancy between faculty reported use and DCs observed use could be faculty preparation. The science faculty may be forewarned of an eminent observation by the DC, thus providing the faculty with the opportunity to prepare and present a lecture session with additional student engagement activities. The survey in this project did not obtain information about the method the DCs used to notify the science faculty about any up-coming class observations.

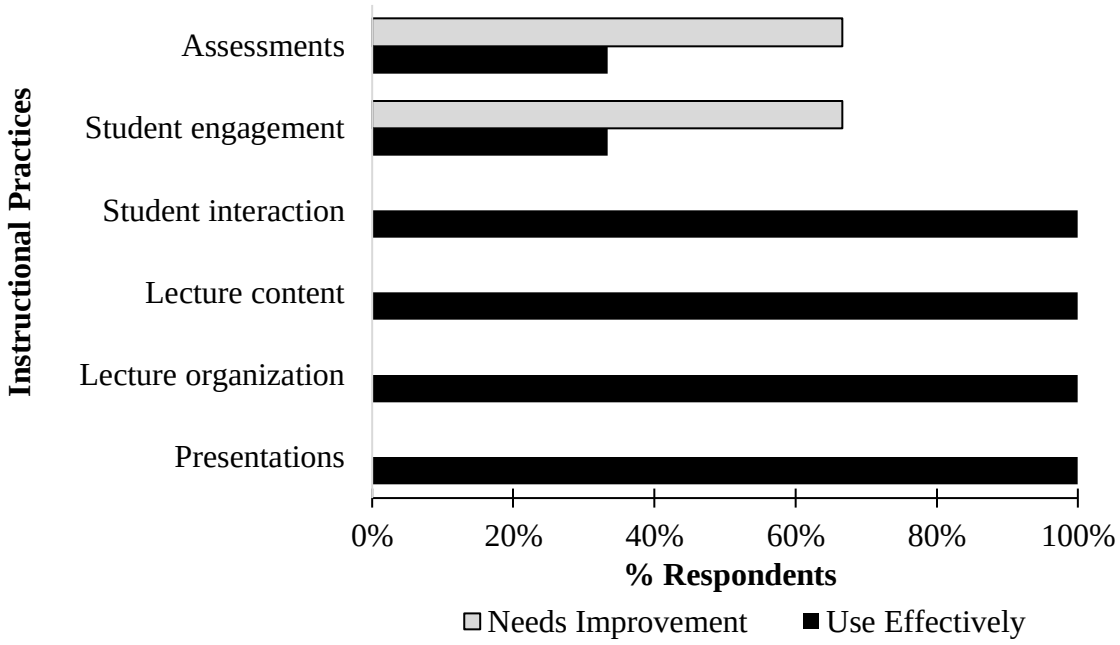


Figure 4 A. Effective Use of Science Faculty Instructional Practices Observed by Department Chairs. *Note: n=3.*

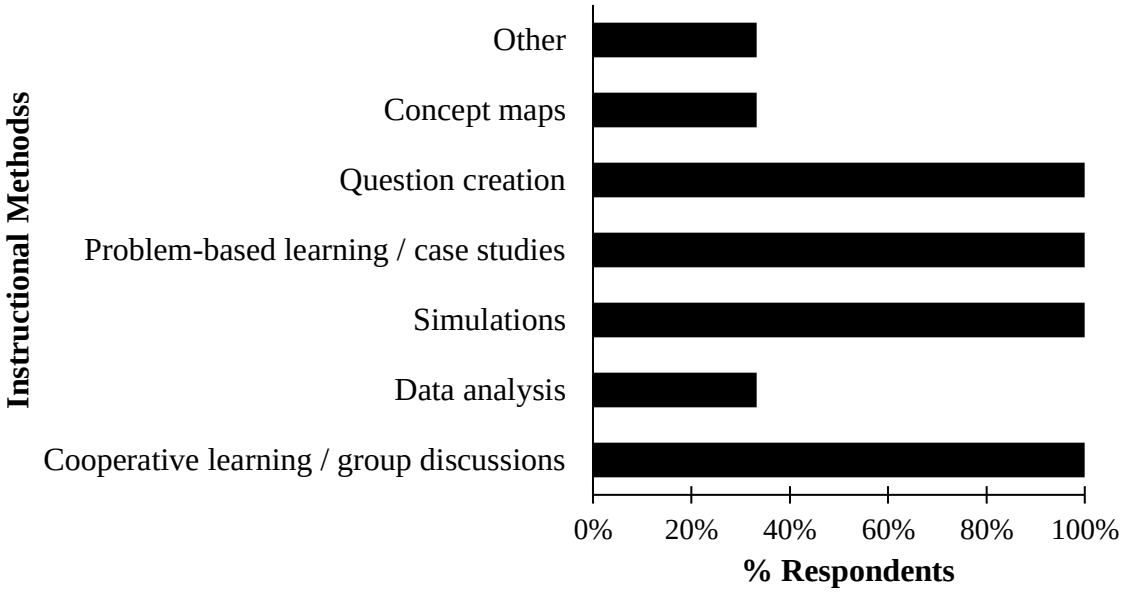


Figure 4B. Identification of Science Faculty Instructional Methods Observed by Department Chairs. *Note: n=3.*

4.4 Key Question 4

Does CCIT offer training in any of the instructional practices that faculty members identify as important for student-centered instruction?

The results in Figure 5 show the PD training opportunities CCIT staff report being offered at the college. The data indicate that CCIT offer PD topics which science faculty, DCs, and CCIT staff report as important student-centered practices and beneficial for science students' education (compare Figure 5 with Figure 3 and Table 3). CCIT staff

report that training topics include: communicating course goals and objectives, group work inside and outside of class, in-class activities, and multimedia instruction. CCIT staff also report that very little training is provided in extensive lecturing or using online modules (10% and 40%, respectively).

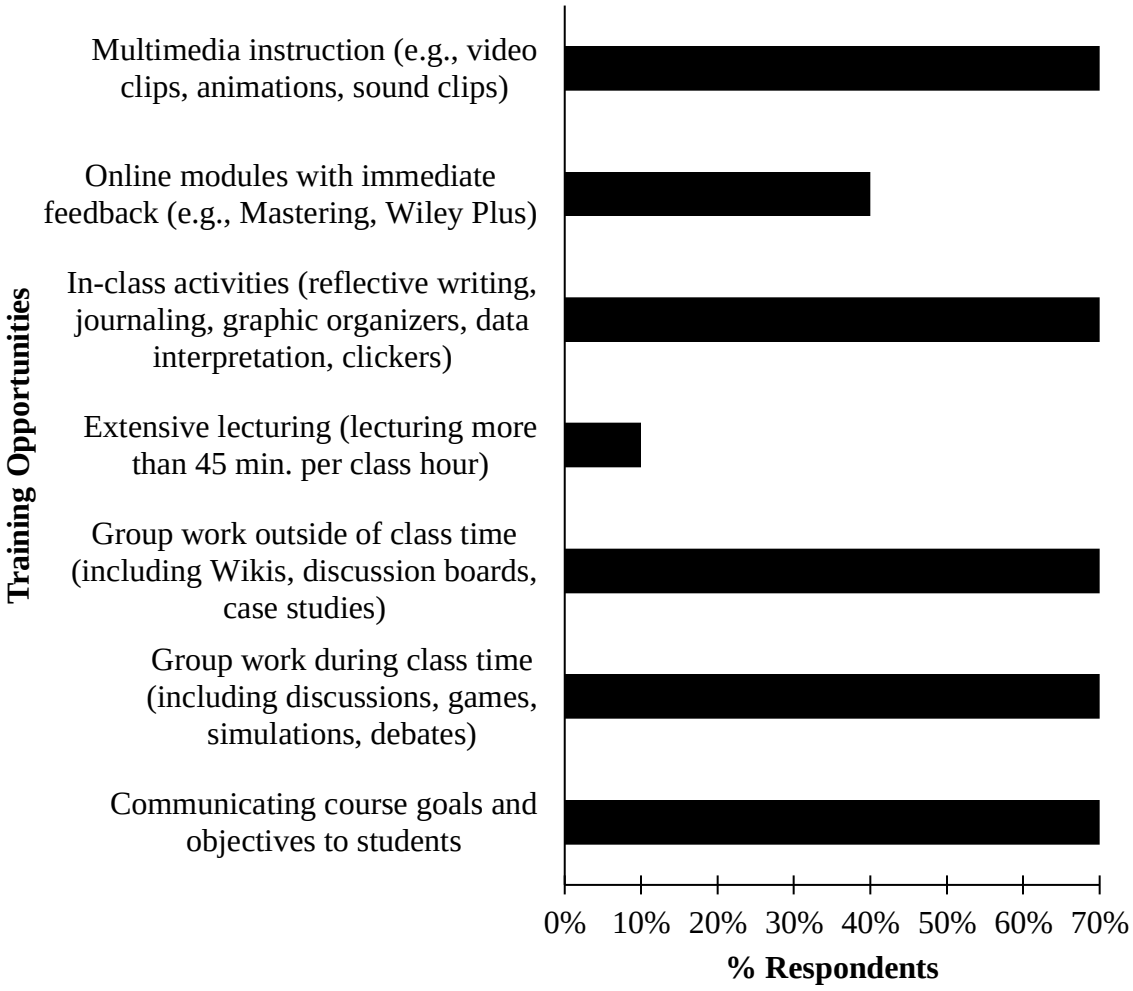


Figure 5. Training Opportunities for Faculty Offered by CCIT as Reported by CCIT Staff. *Note: n=10.*

4.5 Key Question 5

What types of assessments do science faculty use in their courses? Do the assessments used in the science courses reflect student-centered learning outcomes?

Science faculty members were asked to identify which assessment tools they use in their courses and to qualify whether they use these tools for grading students or for identifying student comprehension (no grade). They indicated which assessments they do not use at all or which ones they use for grading or not for grading. The data in Figure 6 indicate that faculty members overwhelmingly use traditional exam questions in the format of multiple choice or true/false (100%, 15/15 faculty), and essay or short answer questions (80%, 12/15 faculty) for grading students. The results also indicate that most science instructors do not use oral presentations, student posters, or mini research papers (80%, 12/15 instructors) or student evaluations of each other's work (73.3%, 11/15 instructors). More than half of the faculty use portfolios, group projects, or lab reports in their course (53.3%, 8/15 instructors), whereas a small number use class participation assessment, such as clickers, games, or mini quizzes (14.29%, 2/14 instructors) for grading students. The number of science faculty members who reported using lab reports in their classes may be under-represented due to the clustering of assessments (portfolios, group projects, lab reports) in that question. In addition, some of the responding faculty members did not teach laboratory-based courses; therefore, they might automatically

have attributed this cluster of assessments to the “do not use” option. If we remove the number of faculty members who do not teach a laboratory course, the overall number of faculty members using lab reports would most likely increase, as this is a frequent laboratory assessment. An equal number of faculty members either did not use class participation assessments or used them without any grade benefit to the students (42.86% did not use or used, but not for grading) (Figure 6).

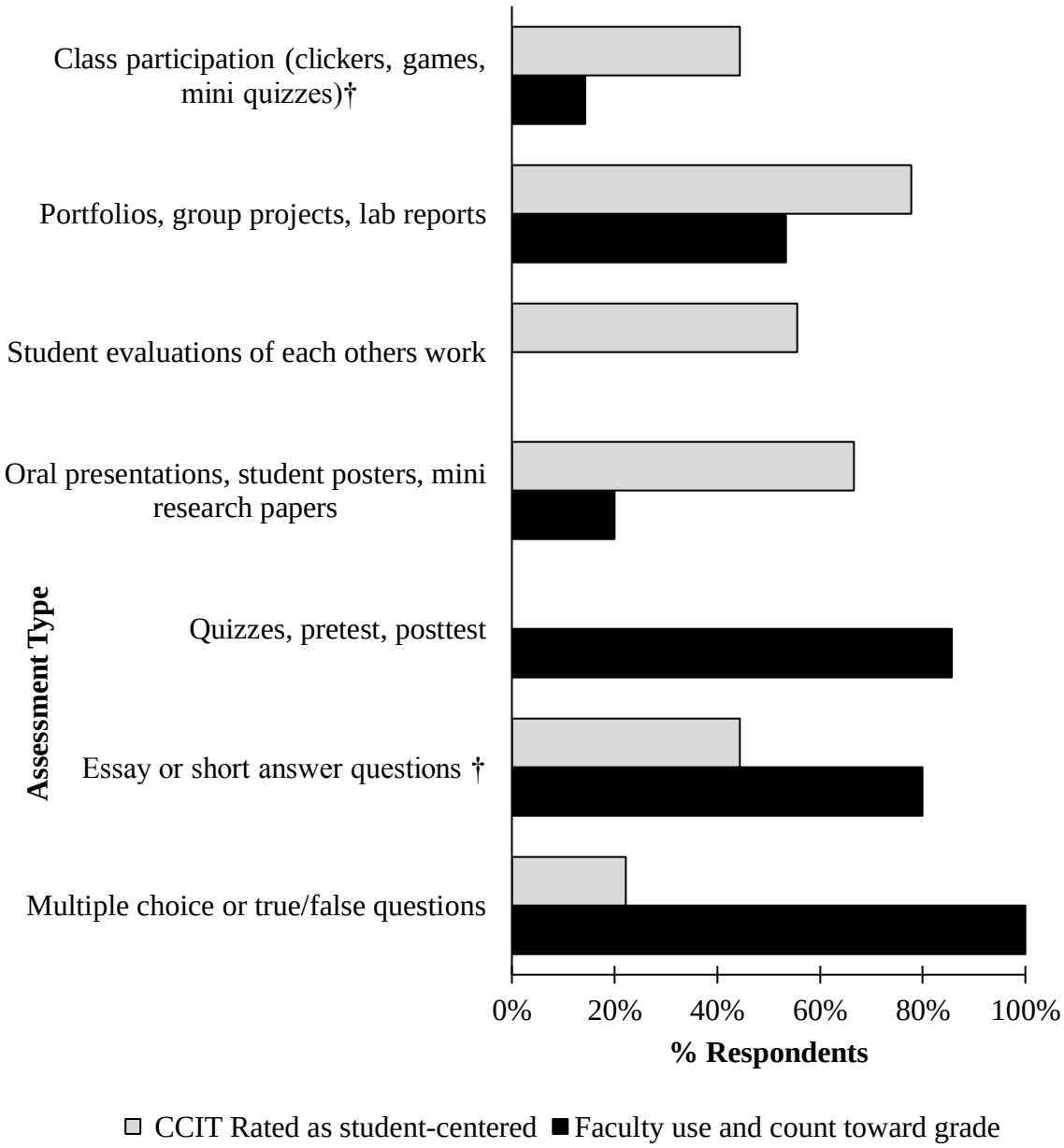


Figure 6: Science Faculty and CCIT Staff Ratings of How Often Assessment Types Are Used andWhich Ones Are Most Student-Centered. *Note: n=15 and † n=14 (Science faculty), n=10 and † n=9 (CCIT staff).*

In survey comments, some of the science faculty said they used other assessment tools but did not indicate whether they were used for grades. The other assessments were (1) worksheets as formative assessments, (2) Pearson MyLab assignments, (3) problem-solving led by students, and (4) various unidentified types of formative assessments (26.6%, 4/15 instructors). CCIT staff reported that training is offered in all assessment methods and that training can be customized to a specific faculty need. Training in the following assessment methods were available to faculty: designing summative assessments, writing essay questions and rubrics, assessing student posters, assessing portfolios, group presentations, lab reports and research papers, pretesting of prior knowledge, and class participation.

4.6 Key Question 6

What perceptions do science faculty, CCIT staff, and DCs have of the different types of training opportunities offered by the CCIT?

This key question was aimed at determining whether the three populations of respondents had similar views as to the benefits of the different CCIT training opportunities. The survey asked science faculty, CCIT staff, and DCs to rank the various CCIT training opportunities as 3 (very beneficial), 2 (beneficial), or 1 (not beneficial). Table 4 shows the mean scores that the three populations gave for training opportunities offered by the CCIT. All three populations perceived the following training sessions or workshops as being very beneficial or beneficial to instructional development:

Instructional Innovation Network and professional conferences, college-wide in-service breakaway sessions and Innovation Checkpoints, one-on-one CCIT training, face-to-face or online college-wide workshops, and peer observations. An ANOVA confirmed that there were no significant differences between the group means for the above PD training opportunities.

Table 4.
Science Faculty, Science Department Chairs, and CCIT Staff Rankings of the Benefits of Various Instructional Development Opportunities.

Instructional Development Opportunities	*Rank score M (SD)*		
	Science faculty	**Dept. chairs**	**CCIT staff**
Instructional Innovation Network or professional organization conferences	2.47 (0.74)	2.00 (1.00)	2.75 (0.45)
College-wide in-service breakaway sessions or Innovation Checkpoints	2.00 (0.66)	1.67 (1.15)	2.55 (0.52)
One-on-one CCIT training	2.25 (0.75)	2.00 (1.00)	2.55 (0.69)
Face-to-face or online college-wide workshops	2.09 (0.83)	2.33 (0.58)	2.17 (0.58)
Peer observation and feedback	2.38 (0.51)	2.67 (0.58)	2.33 (0.78)

Note: Mean rankings based on categories 1 (not beneficial), 2 (beneficial), or 3 (very beneficial).

Figure 7 displays the results of the ANOVA and Tukey's post hoc test. The ANOVA identified that CCIT staff considered portfolio presentations more beneficial than did science faculty and DCs ($F = 12.4$, $df = 26$, $p < 0.01$). There was also a significant difference between CCIT staff and DCs in the rating of Webinars and CCIT courses on pedagogy and technology as beneficial and not beneficial, respectively ($F = 12.4$, $df = 26$, $p < 0.01$). There was also a significant difference between CCIT staff rating Webinars and CCIT courses on pedagogy and technology as beneficial and DCs not ($F = 4.64$, $df = 26$, $p<0.05$). Before making any conclusions based on these data, it should be noted that only three DCs were included in the sample.

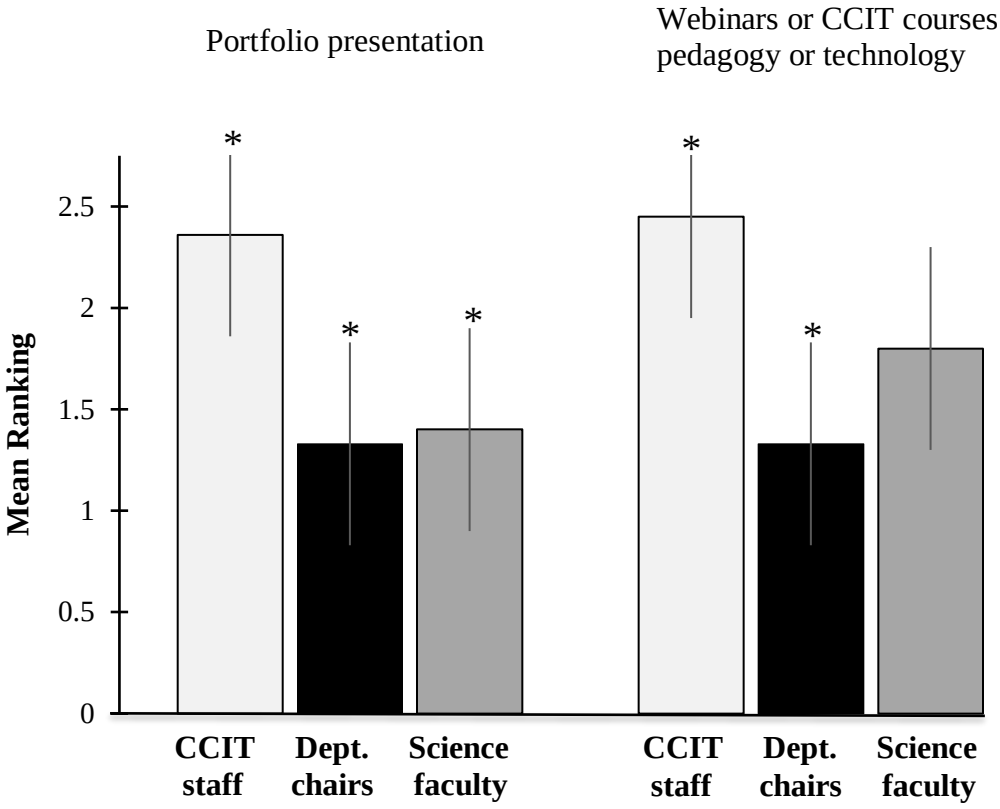


Figure 7. Comparisons Between Science Faculty, Science Department Chairs, and CCIT Staff Ratings of the Benefits of Professional Development Opportunities. *Note n=10 (CCIT staff), n=3 (Dept. chairs), n=15 (Science faculty), *p<0.05*

What makes the DCs' data more convincing is that all three DCs felt that Webinars and CCIT courses on pedagogy or technology should be optional, and that peer observations should be mandatory. There are numerous reports (Hewson et al., 2001; McShannon, 2006; Ebert-May, 2011) supporting the use of peer observation to encourage positive change in pedagogical practice and to enhance colleague engagement.

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Rethinking Traditional Instruction

A report from the NRC (2012) describes the need to rethink the way instruction is being conducted in the undergraduate classroom by understanding how people learn and what factors impact student motivation. The main argument put forth by the authors of the report is that learning is not simply an accumulation of facts but the integration of knowledge with students' experiences and ideas to generate a contextual meaning. Expecting undergraduate students to memorize information leads to increased test anxiety and decreased achievement (Benjamin, 1981; McKeachie, 1972). The instructor needs to address several barriers in the classroom to providing a positive learning environment for undergraduate students, and these barriers are best overcome when the faculty is trained to effectively use pedagogical methods that help students construct knowledge.

The implementation of learner-centered pedagogy in science courses has been demonstrated to be an effective strategy for increasing student participation and for stimulating higher order thinking skills on Bloom's taxonomy. Creating a learner-centered environment results in higher grades (Wilke, 2003; Yuretich, 2003), improves student understanding of the methodology of science (Carvalho & West, 2011; Steury, 2015), and motivates students to seek help and put effort into understanding difficult

scientific concepts (Wright, 1997). Creating such a learning environment requires the support of both the college administration and faculty. The faculty needs to be convinced that these strategies work for improving student performance and must be properly prepared to effectively implement instructional tools that support student engagement. The administration also needs to support faculty efforts to improve by infusing a culture of student learning and creating an institutional faculty training program that iteratively engages in data-driven development of student learning classroom approaches and technologies.

The underlying purpose of a PD program in the context of education is to transform teaching practices, which creates a stimulating learning environment and leads to improved student achievement (Supovitz, 2000). Guskey (1986) describes staff development as a systematic process that alters teaching practices, beliefs, and attitudes, leading toward improving student outcomes. McKeachie (1970) endorses the implementation of teacher training focused on improving student-centered pedagogy to stimulate deeper learning, change attitudes and misconceptions, and sharpen the focus on affective student outcomes. Cross (1986) admits that much of the emphasis in the educational reform movement of the 1980s was on curriculum redesign, rather than pedagogy — "how" students are taught (p. 3). Since then, the NRC (2005) has accumulated data that endorses the use of instructional processes that help students build deep cross-discipline connections while developing new conceptions of the physical world and monitoring their own growth and development. Perez (2012) also explains that

while instructors cannot control students' behavior, they can develop more engaging practices that promote student success.

The emergence of professional training of faculty in community colleges arose, in part, from the realization that students with greater pedagogical needs were progressively making up a greater percentage of the college student population (Watts et al., 2002). Boswell and Wilson (2004), Lail (2009), and Brownell (2012) describe the community college student population as a diverse group of traditional (high school graduates) and non-traditional students (adult learners, unemployed workers, minorities, reverse-transfers, high school seniors, underprepared students, and former military), representing worldwide cultures and ethnicities. Murray (2002) summarizes that all these variables within the community college environment reinforce the need for PD programs that train faculty in the use of pedagogies that support student learning goals.

A review of the literature on learner-centered pedagogical practices yields myriad approaches that appear to have positive effects on student outcomes (Allen & Tanner, 2005; Connell et al., 2016; Deting & Ebert-May, 2010; NRC, 2005), and institutions of higher education are working to integrate effective curricula into their PD programs (Van Ast & Mullen, 1999; Sunal et al., 2001; Ebert-May, 2015). Very few studies on the evaluation of PD programs have directly measured the effect of implementing learner-centered instruction on student grades. The majority of the data arise from surveys asking faculty to self-report their use or change in perceptions, or asking students to self-report perceived benefits of the instructional practices used (Ebert-May, 2015).

In this project, the evaluation of the PD program asked faculty to identify the types of skills they believed were important for science students to obtain from their post-secondary education. The science faculty identified the major skills that national associations (NRC, 2005) also recognize as being important for science students. The instructional practices that faculty members need to create a student-centered atmosphere are congruent with Bloom's higher order knowledge construction and with what CCIT staff and science faculty believe are effective learning strategies according to a national report on science education (NRC, 1999b). Therefore, why are science faculty members self-reporting their limited use of learner-centered practices, despite knowing what methods would work best for their students? The answer may be that science faculty do not believe in the effectiveness of using student-centered pedagogies. It could also be possible that science faculty have attempted to implement some of the practices but did not seek out additional support from CCIT to provide long-term support. Possibly, science faculty did not participate in the relevant training opportunities offered by CCIT and therefore are unable to initiate effective instructional practices. Or, the science faculty may have participated in a training exercise but did not commit more time to further research the integration of the practice into a science-focused course and, therefore, did not make the required modifications prior to introducing the students to the pedagogy.

Guskey (1986) proposes that the ineffectiveness of a PD program can be attributed to two factors: the motivating elements that promote teachers to participate (and accept) the PD, and the process by which faculty members modify their beliefs and behaviors. PD programs should motivate faculty to believe that the training exercises will expand their knowledge and skills, which will manifest as transformed teaching practices and translate into improved student success (Guskey, 2002). Guskey (2002) proposes that PD programs must carefully consider the mechanism of change in teacher beliefs about new instructional methods, as faculty fear failure and embarrassment from incorrectly using a new teaching method. To reduce faculty stress and encourage pedagogical change, PD programs should maintain long-term support of faculty practices by consulting faculty members often, creating modified strategies to cater to discipline-specific needs, and observing classroom practices. This is what Guskey (2002) calls follow-up, support, and pressure.

Table 4 indicates that science faculty and CCIT staff believe that many of the development offerings, such as one-on-one training, workshops, and peer observations, are beneficial, but this study did not gather evidence as to whether faculty participated in any of these activities, except for the mandatory sessions during in-service training. This evaluation did not gather data on the extent to which the faculty participated in any additional courses outside the NFD program requirements, but this might be a future element to investigate.

The types of student assessments that faculty members reported using (Figure 6) were predominantly in the form of multiple choice and true/false questions, considered to be on the lower level of Bloom's taxonomy. Many faculty members reported using essay and short answer questions as well, but most did not use other assessments (oral presentations, student posters or mini research papers, clickers, games, or mini quizzes) associated with active-learning practices. More than half the instructors reported using group projects, portfolios, or lab reports, but these results are most likely skewed for several reasons. First, all science faculty members were surveyed including those who were not teaching a lab-based course; therefore, some faculty members may not have answered this question due to the inclusion of the term "lab reports." Second, the number of faculty members reporting the use of lab reports was underestimated because faculty members who do not teach a laboratory component may have opted to place this choice in the "do not use" box. Third, some biology courses include a computer-based lab component, which some faculty members may consider as being a true science lab, whether or not the students participate in inquiry learning. Fourth, some courses use laboratory manuals that contain a lab report component, which involves answering some multiple-choice questions, labeling diagrams, or filling in the blank questions, which some might consider as not being true inquiry-based pedagogy. It is with these considerations in mind that the use of lab reports must be clarified in order to provide a more accurate interpretation of the survey results.

5.2 Findings

The most striking element of this survey project is the discrepancy between science faculty members' reported use of student-centered practices and their acknowledgement of what effective pedagogical practices are that support science students' development of needed skills. Although the PD program offers training in learner-focused pedagogy, science faculty members are either reluctant to use the training, are unprepared to implement the training, or do not believe that the instructional efforts will benefit the students. This study did not elucidate the extent to which the faculty participated in any development opportunities focused on pedagogy or whether the PD program provides extended support to faculty. One possibility for the disparity could be that the science faculty have not expressed their discipline-specific needs to the program developers. According to Kirkpatrick (1985), the content of a PD program should be determined on the basis of the needs of stakeholders (specifically teaching effectiveness for students) and what the expected outcomes are for the program. Moreover, content expert presenters who are highly skilled in communicating, maintaining audience attention, and using various engagement tools/technologies should provide the training in a learning-appropriate venue (Guskey, 2002; Kirkpatrick, 1985). The results of this project did not identify the effectiveness of CCIT training sessions and there is no evidence to support conducting such an evaluation.

The characteristics of a PD program that Ellison (2004) and Tierney (1996) describe point to a program that is teacher needs-driven and school mission-driven, built on a co-constructivist model incorporating topics that expand and enhance instructor

behaviors, knowledge, and attitudes about learning, with a focus on institutional goals and student achievement. Ellison (2004) adds that effective PD programs should exhibit certain characteristics of quality and undergo an evaluation to document the value provided to the institution's stakeholders, which include its students. The evaluation is paramount to the continuation of the program because the evaluation will assess whether the program is effective and whether the college resources are being productively utilized (Watts et al., 2002). Guskey (2002) endorses program evaluation as a means to determine teacher competence, which is the primary linkage between PD effectiveness and student achievement.

5.3 Program Strengths

There are several strengths of the college-wide CCIT division identified in this study that deserve mentioning. The results clarify that the CCIT curriculum is focused and well planned, providing effective development opportunities to faculty with the expectation of creating a faculty that is proficient in effective pedagogical practices. This study shows that CCIT staff understand student-centered instruction and that many of these qualities are also essential for science faculty to be effective instructors. Science faculty also identified the characteristics of student-centered instruction and the skills important to science students. CCIT staff also understand which assessment methods are compatible with accurately measuring cognitive learning in the context of a student-focused instructional environment. CCIT staff are learned professionals who can provide expert support to faculty given the opportunity and resources.

CCIT is offering faculty and counselors training options that are consistent with the theories and practices identified as student-centered instruction. This supports the conclusion that the CCIT staff are staying current with the new theories in pedagogical content knowledge, student learning, and the development of novel technologies to exercise those instructional practices making the CCIT division a department under constant change. CCIT staff remain apprised of the dynamic nature of pedagogical theories and technologies, build a solid knowledge base for research-supported practices, request funding for their acquisition or training, and design development opportunities for faculty within a reasonable time span.

5.4 Recommendations for Program Improvement

This executive position paper was conducted to identify whether the science faculty are implementing student-focused instructional practices and whether participation in PD activities has affected instructional performance in science courses at DTCC. Upon careful review of the results, the following recommendations are suggested:

1. **Embrace Active Learning**

   Science faculty self-report that they are using extensive lecturing in the classroom, although they recognize the student-centered methods that would improve student outcomes (Table 4B). It is possible that the barriers to using

active-learning practices stem from several sources. Brownell and Tanner (2012) indicate that the three most common hurdles to utilizing effective instructional practices is time, training and incentives. While this research project did not address the role of release time and incentive opportunities affecting the use of student-focused methods, there was clear evidence that faculty training was available. In fact, the science faculty reported that the CCIT offerings were beneficial to faculty (Table 4). Dancy et al. (2016) identify two possible reasons for the lack of effective pedagogical implementation: faculty have modified the method, and in doing so removed an essential element to its success, or the faculty are unclear about the components of the strategy that makes it effective. The college needs to develop strategies for expressing learning goals to students and monitoring student knowledge construction by incorporating metacognitive practices, which help students follow their own learning progression (NRC, 1999a, p. 22).

It would be worthwhile for CCIT and department chairs to make science faculty aware specifically of the importance of student-centered pedagogy, and to provide integrated support and follow-up to science faculty during the design and implementation stages, as well as during faculty observation and evaluation.

2. Leverage Faculty Learning Communities

Create a college-wide, discipline-based learning community to bolster science faculty collaboration, explore novel instructional practices across campuses, and

invigorate faculty to strive for teaching excellence. Marbach-Ad et al. (2014) clearly show that a learning community of science faculty that has shared classroom experiences, discusses new instructional practices, and collaborates within the same discipline has a positive impact on student outcomes. Cox (2004) states that learning communities help faculty overcome some of the hurdles of classroom pedagogy by creating an atmosphere of trust and a common goal to transform instructional practices. This indicates that FLCs composed of teachers with similar interests and goals produce a constructive working environment that enables student success. Together with the NFD program and other PD activities, a discipline-based FLC may encourage student-centered instruction by the science faculty.

3. **Improve Communication and Embrace Understanding**

   Enhance the college-wide message that CCIT provides long-term PD support to faculty implementing novel teaching strategies and, upon request, monitor instructional practices using peer observation and consultation. The lack of student-centered instruction by the science faculty may be due to the infrequency of the science faculty seeking extended support by CCIT staff.

4. **Understand Trends in Professional Development**

   CCIT should continue to create PD activities based on data-supported, discipline-specific research about pedagogies that encourage student-centered learning. To support faculty engagement in PD, CCIT should continue utilizing learner-

centered PD activities. Lindblom-Ylanne (2006) and Ebert-May (2011) indicate that PD programs that simply introduce new pedagogies without participant engagement do not result in instructors who maintain their new practice over time. Together, these measures will sustain the culture of encouragement and support to the science faculty.

5. Celebrate our Successes

Consider providing rewards/incentives to faculty members showing proficient and continued use of learner-centered instruction with concomitant increases in student outcomes. Murray (1999, 2002) identifies PD programs that were less effective when faculty members were not incentivized to instructionally perform, but those same faculty members exerted more effort in their research practice because of promotional considerations. DTCC does offer faculty excellence in teaching awards, but only one full-time faculty member for every campus is chosen per year, and the decision is based on a nomination and an extensive self-reporting process. In other words, it is not an open competition in which any faculty member can self-nominate and submit to an extensive evaluation of teaching practices and student outcomes. There are several potential options that the college and CCIT could offer to faculty exhibiting instructional success. First, CCIT could provide faculty with "Certificates of Improvement or Success" for showing effective implementation of student-centered pedagogy. Second, CCIT could gather artifacts from faculty demonstrating successful implementation of student-centered pedagogy. These artifacts could be maintained in an online

library which other faculty could use in their classroom practices. Third, the college could introduce an "instructional success" portion in the faculty evaluation form that specifically highlights the achievements in teaching. Finally, the college and CCIT could provide opportunities for successful faculty to present their approaches at in-service or conferences. While these options have a small or little financial impact on college resources, they would require approval by the administration and recommendations from all instructional divisions.

6. Leverage the Power of Peer Observations

Kohut, Burnap, and Yon (2007) describe peer observation as a way to "review the teaching process and its possible relationship to learning" (p. 20). Additionally, observers need proper training in maintaining their objectivity and developing their observational skills to uphold the process as authentic and rigorous. Faculty want to be assured that the observers are assessing them consistently compared to other faculty. Msila (2009) reports that peer observation is a critical tool for improving teaching quality by supporting instructional development. When peer observation was not regarded by faculty as supportive, Msila (2009) found that teachers had doubts about the effectiveness of changing their instructional practice and being involved in the improvement strategies. Atkinson and Bolt (2010) proposed that faculty will embrace peer observation as an improvement tool when the process is voluntary, the institution provides continual support, and the observers are external to the department. Science faculty and DCs gave peer

observation a high rating as being beneficial to their pedagogy (Table 4). This is indicative that faculty want to improve their practice and that they understand that a constructive discourse about effective teaching strategies provides teachers with support and encouragement. CCIT can promote voluntary peer observations and provide a structured rubric highlighting instructional improvements. These measures will create an atmosphere of collaboration and avoid the evaluative atmosphere to entice more science faculty to participate.

7. Help Faculty Target Student Study Skills in Their Pedagogy

This research project focused on identifying science faculty beliefs and practices in the classroom, and PD opportunities that might facilitate best practices of pedagogy. Identifying student study skills and demonstrating appropriate study methods to science students by faculty is one perspective that was not examined in this project. In fact, according to the results in Table 6, science faculty predominantly incorporate multiple choice questions in their assessments, which is a suitable assessment format for the recitation-style lecturing that most science faculty report using here and in other studies (Supovitz and Turner, 2000). Supovitz and Turner (2000) and the AAAS (2010) assert that effective professional development should enrich the content knowledge of faculty, and by extension, students should have a stronger grasp of the content when they are "developed" in a similar manner. This will help students succeed in the active learning environment which will motivate faculty to pursue new student-centered

instructional practices. This process of faculty transformation underscores the concept that Guskey (2002) described as a successful PD design.

8. Redefine What It Means to Be a Scientist and an Instructor: Pedagogical Content Knowledge (PCK)

Pedagogical content knowledge (PCK) is described by Shulman (1987) as the "blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction" (p. 8). PCK can be characterized as the ability to transform the subject matter into an educational experience for the student in which the student actively gains understanding of the content in a student-centered environment. Developing PCK is an iterative process, developing over time and in phases. The factors influencing PCK emergence and progression are based on how the teacher was taught (educational experience), how the teacher viewed the topic being presented (whether it needed special considerations or was straightforward knowledge intake), and teachers' own misconceptions of the content (Kind, 2009). Alternatively, Wongsopawiro et al. (2017) explain that PCK can be gradually acquired and cultivated through action research PD. Action research creates an environment whereby teachers reflect on their pedagogy as a function of student outcomes. This project identified that science faculty understand what skills science students need to be successful (Table 1) and that CCIT provides effective topics of professional

development (Figure 5). By extension, we can infer that science faculty at DTCC needs to better develop their PCK in order to improve student success. Designing a PD program for science faculty that uses the concepts of science, while incorporating the tools of best practices in pedagogy, will help establish a student-centered and inquiry-based educational environment that reflects the experience of science knowledge construction.

The results presented in this executive position paper have revealed that science faculty at DTCC recognize effective student-centered, active-learning instructional practices but self-report that they are not implementing those practices in the classroom. Furthermore, CCIT program developers and science faculty report that CCIT are providing the college faculty with a PD training curriculum that promotes student-centered instruction. In conclusion, the recommendations presented focus on specific ways to improve science faculty instruction, in part, by better utilization and implementation of the existing PD opportunities.

Implementation of these recommendations with follow-up evaluations of both the instructional practices of science faculty and student outcomes can lead to an effective college-integrated faculty training program that can bolster the college mission with a focus on student achievement.

REFERENCES

Allen, D., & Tanner, K. (2005). Infusing active learning into the large-enrollment biology class: Seven strategies, from the simple to complex. *Cell Biology Education, 4*(4), 262-268. doi: 10.1187/cbe.05-08-0113

Alpert, D. (1985). Performance and paralysis: The organizational context of the American research university. *The Journal of Higher Education, 56*(3), 241-281. doi: 10.2307/1981734

American Association for the Advancement of Science (AAAS). (2010). *Vision and change: A call to action*. Washington, DC.

Atkinson, D. J. & Bolt, S. (2010). Using Teaching Observations to Reflect Upon and Improve Teaching Practice in Higher Education. *Journal of Scholarship of Teaching and Learning, 10(3),* 1-19.

Auerbach, A. J., & Schussler, E. (2017). A Vision and Change Reform of Introductory Biology Shifts Faculty Perceptions and Use of Active Learning. *Cell Biology Education, 16*(4). doi:10.1187/cbe.16-08-0258

Avery, Z. K., & Reeve, E. M. (2013). Developing Effective STEM Professional Development Programs. *Journal of Technology Education, 25*(1). doi:10.21061/jte.v25i1.a.4

Beach, A. L., Henderson, C., & Finkelstein, N. (2012). Facilitating Change in Undergraduate STEM Education. *Change: The Magazine of Higher Learning, 44*(6),

52-59. doi:10.1080/00091383.2012.728955

Beichner, R. J., & Saul, J. M. (2001). An Activity-based Curriculum for Large Introductory Physics Classes: The SCALE-UP Project. *2001 Physics Education Research Conference Proceedings*. doi:10.1119/perc.2001.pr.016

Benjamin, M., & Others, A. (1981). Test anxiety: Deficits in information processing. *Journal of Educational Psychology, 73*(6), 816-24.

Bernold, L. E., Spurlin, J. E., & Anson, C. M. (2007). Understanding our students: A longitudinal-study of success and failure in engineering with implications for increased retention. *Journal of Engineering Education, 96*(3), 263-274. 10.1002/j.2168-9830.2007.tb00935

Bettinger, E. (2010). To be or not to be: Major choices in budding scientists. *In C.T. Clotfelter (ed.) American universities in a global market.* (pp. 69-98) Chicago: University of Chicago Press.

Biggs, J. (1996). Enhancing teaching through constructive alignment. *Higher Education, 32*(3), 347-364. doi:10.1007/bf00138871

Birol, G., Briseño-Garzón, A., & Han, A. (2017). Faculty teaching practices and perceptions: Comparative analysis based on time spent lecturing. *Collected Essays on Learning and Teaching, 10*, 27-44. doi:10.22329/celt.v10i0.4750

Blaisdell, M. L., & Cox, M. D. (2004). Midcareer and senior faculty learning communities: Learning throughout faculty careers. *New Directions for Teaching and Learning*, (97), 137-148. doi:10.1002/tl.140

Bloom, B. S., Krathwohl, D. R., & Masia, B. B. (1984). *Taxonomy of educational*

objectives; the classification of educational goals. New York: Longman, Green.

Boswell, K. & Wilson , C. D. (2004). *Keeping America's promise: A report on the future of the community college*. Denver, CO: Education Commission of the States and the League for Innovation in the Community College.

Bouwma-Gearhart, J. (2012). Science faculty improving teaching practice: Identifying needs and finding meaningful professional development. *International Journal of Teaching and Learning in Higher Education, 24*(2), 180-188.

Brown, T. W., Killingsworth, K., & Alavosius, M. P. (2014). Interteaching: An evidence-based approach to instruction. *International Journal of Teaching and Learning in Higher Education, 26*(1), 132-139.

Brownell, S. E., & Tanner, K. D. (2012). Barriers to faculty pedagogical change: Lack of training, time, incentives, and … tensions with professional identity? *CBE - Life Sciences Education, 11*(4), 339-346.

Byrne, B., & Guy, R. (2016). Interteaching within a human physiology course: A comparison of first- and second-year students' learning skills and perceptions. *Advances in Physiology Education, 40*(3), 349-353. doi: 10.1152/advan.00141.2015

Cambridge, B. L. (2005). *Promoting student success: What new faculty need to know* (Occasional Paper No. 12). Bloomington, Indiana: Indiana University Center for Postsecondary Research.

Carloye, L. (2017). Case study: Mini-case studies: Small infusions of active learning for large-lecture courses. *Journal of College Science Teaching, 46*(6), 63-67.

Carnegie Foundation for the Advancement of Teaching, William and Flora Hewlett

Foundation. (2008). *Strengthening pre-collegiate education in community colleges: Project summary and recommendations.* Carnegie Foundation for the Advancement of Teaching.

Carvalho, H., & West, C. A. (2011). Voluntary participation in an active learning exercise leads to a better understanding of physiology. *Advances in Physiology Education, 35*(1), 53-58.

Chen, X. (2009). *Students who study science, technology, engineering, and mathematics (STEM) in postsecondary education.* (No. NCES 2009161). U.S. Department of Education: National Center for Education Statistics.

Chen, X. (2015). STEM attrition among high-performing college students in the United States: Scope and potential causes. *Journal of Technology and Science Education, 5*(1), 41-59.

Chen, X., National Center for, Education Statistics, & International, R. (2013). *STEM attrition: College students' paths into and out of STEM fields. Statistical analysis report. NCES 2014-001*. National Center for Education Statistics.

Chi, M. T. (2009). Active-Constructive-Interactive: A conceptual framework for differentiating learning activities. *Topics in Cognitive Science, 1*(1), 73-105. doi: 10.1111/j.1756-8765.2008.01005

Chin, C., & Chia, L. (2006). Problem-based learning: Using ill-structured problems in biology project work. *Science Education, 90*(1), 44-67. doi.org/10.1002/sce.20097

Coil, D., Wenderoth, M. P., Cunningham, M., & Dirks, C. (2010). Teaching the process of science: Faculty perceptions and an effective methodology. *CBE Life Sciences*

Education, 9(4), 524-535. doi:10.1187/cbe.10-01-0005

Connell, G. L., Donovan, D. A., & Chambers, T. G. (2015). Increasing the use of student-centered pedagogies from moderate to high improves student learning and attitudes about biology. *CBE Life Sciences Education, 15*(1). doi: 10.1187/cbe.15-03-0062

Corbett, H. D., Wilson, B. L., & Research for Better Schools, I. P. (1990). *Unintended and unwelcome: The local impact of state testing*. (Office of Educational Research and Improvement (ED), Washington, DC.). Philadelphia, PA: Research for Better Schools.

Cox, M. D. (2004). Introduction to faculty learning communities. *New Directions for Teaching and Learning,* (97), 5-23. doi: org/10.1002/tl.129

Cross, K. P. (1986, March). Taking teaching seriously. Paper presented at the *Annual Meeting of the American Association for Higher Education,* Washington, DC. 1-15.

Daempfle, P. A. (2004). An analysis of the high attrition rates among first year college science, math, and engineering majors. *Journal of College Student Retention, 5*(1), 37-52.

Department of the Interior, Bureau of Education. (1917). *Monthly record of the current educational publications.* (Bulletin No. 1). Washington Government Printing Office.

Derting, T. L., Ebert-May, D., Henkel, T. P., Maher, J. M., Arnold, B., & Passmore, H. A. (2016). Assessing faculty professional development in STEM higher education: Sustainability of outcomes. *Sci Adv, 2*(3) doi:10.1126/sciadv.1501422

DTCC Webmaster. (2018). Center for creative instruction and technology. Retrieved

from WWW.DTCC.EDU/CCIT

Ebert-May, D., Derting, T. L., Henkel, T. P., Maher, J. M., Momsen, J. L., Arnold, B., & Passmore, H. A. (2015). Breaking the cycle: Future faculty begin teaching with learner-centered strategies after professional development. *CBE - Life Sciences Education, 14*(2) doi:10.1187/cbe.14-12-0222

Ebert-May, D., Derting, T. L., Hodder, J., Momsen, J. L., Long, T. M., & Jardeleza, S. E. (2011). What we say is not what we do: Effective evaluation of faculty professional development programs. *Bioscience, 61*(7), 550-558. doi:10.1525/bio.2011.61.7.9

Elliott, R. W., & Oliver, D. E. (2016). Linking faculty development to community college student achievement: A mixed methods approach. *Community College Journal of Research and Practice, 40*(2), 85-99.

Ellison, C. M. (2004). Talent development professional development evaluation model: A paradigm shift. *New Directions for Evaluation,* (101), 63-78.

Entezari, M., & Javdan, M. (2016). Active learning and flipped classroom, hand in hand approach to improve students learning in human anatomy and physiology. *International Journal of Higher Education, 5*(4), 222-231.

Fairweather, J. S., & Paulson, K. (2008). In Välimaa J., Ylijoki O. H. (Eds.), *The evolution of American scientific fields: Disciplinary differences versus institutional isomorphism.* Dordrecht, London: Springer.

Farrell, J. J., Moog, R. S., & Spencer, J. N. (1999). A guided-inquiry general chemistry course. *Journal of Chemical Education, 76*(4), 570. doi: 10.1021/ed076p570

Faurer, J., Sutton, C., & Worster, L. (2014). Faculty mentoring: Shaping a program.

Contemporary Issues in Education Research, 7(2), 151-154.

Feldon, D. F., Timmerman, B. C., Stowe, K. A., & Showman, R. (2010). Translating expertise into effective instruction: The impacts of cognitive task analysis (CTA) on lab report quality and student retention in the biological sciences. *Journal of Research in Science Teaching, 47*(10), 1165-1185.

Fink, L. D. (2013). Innovative ways of assessing faculty development. *New Directions for Teaching and Learning,* (133), 47-59.

Fisher, P., Zeligman, D., & Fairweather, J. (2005). Self-assessed student learning outcomes in an engineering service course. *International Journal of Engineering Education, 21*, 446-456.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proc Natl Acad Sci USA, 111*(23), 8410.

Gaff, J. G., & Justice, D. O. (1978). Faculty development yesterday, today, and tomorrow. *New Directions for Higher Education*, 24, 85-98.

Gonzalez, B. Y. (2014). A six-year review of student success in a biology course using lecture, blended, and hybrid methods. *Journal of College Science Teaching, 43*(6), 14-19.

Guskey, T. R. (1986). Staff development and the process of teacher change. *Educational Researcher, 15*(5), 5-12.

Guskey, T. R. (1994). Results-oriented professional development: In search of an optimal mix of effective practices. *Journal of Staff Development, 15*(4), 42-50.

Guskey, T. R. 2000. *Evaluating Professional Development*, Thousand Oaks, CA: Corwin Press.

Guskey, T. R. (2002). Professional development and teacher change. *Teachers and Teaching, 8*(3), 381-391. doi:10.1080/135406002100000512

Guskey, T.R., & Sparks, D. (2002, April). Linking professional development to improvements in student learning. Paper presented at the annual meeting of the American Educational Research Association.

Handelsman, J., Ebert-May, D., Beichner, R., Bruns, P., Chang, A., DeHaan, R., & Wood, W. B. (2004). Scientific teaching. *Science, 304*(5670), 521.

Haspel, C., Motoike, H. K., & Lenchner, E. (2014). The implementation of clay modeling and rat dissection into the human anatomy and physiology curriculum of a large urban community college. *Anatomical Sciences Education, 7*(1), 38-46.

Hativa, N. (1993). Attitudes towards instruction of faculty in mathematics and the physical sciences. *International Journal of Mathematical Education in Science and Technology, 24*(4), 579-593. doi:10.1080/0020739930240410

Henderson, C., Beach, A., & Finkelstein, N. (2011). Facilitating change in undergraduate STEM instructional practices: An analytic review of the literature. *Journal of Research in Science Teaching, 48*(8), 952-984.

Henderson, C., & Dancy, M. H. (2008). Physics faculty and educational researchers: Divergent expectations as barriers to the diffusion of innovations. *American Journal of Physics, 76*(1), 79-91.

Henderson, C., & Dancy, M. H. (2011). *Increasing the Impact and Diffusion of STEM Education Innovations,* New Orleans, LA.

Hewson, M. G., Copeland, H. L., & Fishleder, A. J. (2001). What's the use of faculty development? Program evaluation using retrospective self-assessments and independent performance ratings. *Teaching and Learning in Medicine, 13*(3), 153-60.

Ho, A., Watkins, D. & Kelly, M. (2001). The conceptual change approach to improving teaching and learning: An evaluation of a Hong Kong staff development programme. *Higher Education*, 42: 143–169.

Hubball, H., Clarke, A., & Beach, A. L. (2004). Assessing faculty learning communities. *New Directions for Teaching and Learning,* (97), 87-100.

Hutchins, K. L., & Friedrichsen, P. J. (2012). Science faculty belief systems in a professional development program: Inquiry in college laboratories. *Journal of Science Teacher Education, 23*(8), 867-887.

Hutchins, K., Arbaugh, F., Abell, S., Marra, R., & Lee, M. (2008). A consumer guide to professional development. *Science Scope, 31*(8), 16-19.

Ingvarson, L., Meiers, M., & Beavis, A. (2005). Factors affecting the impact of professional development programs on teachers knowledge, practice, student outcomes & efficacy. *Education Policy Analysis Archives, 13,* 10. doi:10.14507/epaa.v13n10.2005

Jagoda, P., Gilliam, M., McDonald, P., & Russell, C. (2015). Worlding through play: Alternate reality games, large-scale learning, and "the source". *American Journal of Play, 8*(1), 74-100.

Jin, G., & Bierma, T. (2013). STEM for non-STEM majors: Enhancing science literacy in large classes. *Journal of College Science Teaching, 42*(6), 20-26.

Kardash, C. M., & Wallace, M. L. (2001). The perceptions of science classes survey: What undergraduate science reform efforts really need to address. *Journal of Educational Psychology, 93*(1), 199-210.

Kelley, F. J (1950). Toward better college teaching. *Bulletin, no. 13.* Office of Education, Federal Security Agency.

Kind, V. (2009). Pedagogical Content Knowledge in Science Education: Perspectives and Potential for Progress. *Studies in Science Education, 45(2),* 169-204.

Kirkpatrick, D.L. (1977). Evaluating training programs: Evidence vs. proof. *Training and Development Journal, 31*(11), 9-12.

Kirkpatrick, D. L. (1985). Effective supervisory training and development, part 2: In-house approaches and techniques. *Personnel, 62*(1), 52-56.

Knight, J. K., & Wood, W. B. (2005). Teaching more by lecturing less. *Cell Biology Education, 4*(4), 298-310.

Konopka, C. L., Adaime, M. B., & Mosele, P. H. (2015). Active teaching and learning methodologies: Some considerations. *Creative Education, 6*(14), 1536.

Kucsera, J. V., & Svinicki, M. (2010). Rigorous evaluations of faculty development

programs. *Journal of Faculty Development, 24*(2), 5-18.

Kuhot, G. F., Burnap, C., & Yon, M. G. (2007). Peer Observation of Teaching: Perceptions of the Observer and the Observed. *College Teaching,* 55(1), 19-25.

Lail, A. A. (2009). Are new faculty prepared to teach diverse learners? *Inquiry*, *14*(1), 29-40.

Lindblom-Ylanne, S., Trigwell, K., Nevgi, A., & Ashwin, P. (2006). How approaches to teaching are affected by discipline and teaching context. *Studies in Higher Education, 31*(3), 285-298.

Marbach-Ad, G., Ziemer, K. S., Orgler, M., & Thompson, K. V. (2014). Science teaching beliefs and reported approaches within a research university: Perspectives from faculty, graduate students, and undergraduates. *International Journal of Teaching and Learning in Higher Education, 26*(2), 232-250.

McKeachie, W. J. (1972) Improving Teaching Effectiveness. E.R.I.C. Document No. 25. Washington, D.C.: Government Printing Office.

McKeachie, W. (1970). *Research on college teaching: A review.* Washington DC: ERIC Clearinghouse on Higher Education.

McShannon, J., Hynes, P., Nirmalakhandan, N., Venkataramana, G., Ricketts, C., Ulery, A., & Steiner, R. (2006). Gaining Retention and Achievement for Students Program: A Faculty Development Program. *Journal of Professional Issues in Engineering Education and Practice, 132*(3), 204-208. doi:10.1061

Moravec, M., Williams, A., Aguilar-Roca, N., & O'Dowd, D. K. (2010). Learn before lecture: A strategy that improves learning outcomes in a large introductory biology

class. *CBE - Life Sciences Education, 9*(4), 473-481.

Msila, V. (2009). Peer Evaluation: Teachers Evaluating One Another for an Effective Practice. *The International Journal of Learning, 16(6),* 541-557.

Murray, J. P. (1995). Faculty (mis)development in Ohio 2-year colleges. *Community College Journal of Research and Practice, 19*(6-), 549-63.

Murray, J. P. (1999). Faculty development in a national sample of community colleges. *Community College Review, 27*(3), 47-64. doi:10.1177/009155219902700304

Murray, J. P. (2002). Faculty development in SACS-accredited community colleges. *Community College Review, 29*(4), 50-66.

National Academies of Sciences, Engineering, and Medicine. (2015). *Science Teachers Learning: Enhancing Opportunities, Creating Supportive Contexts*. Committee on Strengthening Science Education through a Teacher Learning Continuum. Washington, DC: The National Academies Press. doi:10.17226/21836

National Academies of Sciences, Engineering, and Medicine. (2016a). *Barriers and Opportunities for 2-Year and 4-Year STEM Degrees: Systemic Change to Support Students' Diverse Pathways*. Washington, DC: The National Academies Press. doi:10.17226/21739

National Academies of Sciences, Engineering, and Medicine. (2016b). *Science Literacy: Concepts, Contexts, and Consequences*. Washington, DC: The National Academies Press. doi:10.17226/23595

National Research Council. (1996). *From Analysis to Action: Undergraduate Education in Science, Mathematics, Engineering, and Technology*. Washington, DC: The

National Academies Press. doi: org/10.17226/9128.

National Research Council and National Academy of Engineering. (2012). Olson, S. & Labov, J. B. (Eds.), *Community Colleges in the Evolving STEM Education Landscape: Summary of a Summit*. Washington, DC: The National Academies Press. doi:10.17226/13399.

National Research Council. (1999a). Donovan M. S., Bransford, J. D. & Pellegrino, J. W. (Eds.), *How people learn: Bridging research and practice*. Washington, DC: The National Academies Press. doi:10.17226/9457

National Research Council. (1999b). *Transforming Undergraduate Education in Science, Mathematics, Engineering, and Technology*. Washington, DC: The National Academies Press. doi:10.17226/6453

National Research Council. (2005). Donovan, M. S., and Bransford, J. D. (Eds.) *How Students Learn: Science in the Classroom*. Committee on *How People Learn*, A targeted Report for Teachers, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press. doi:10.17226/11102.

Olimpo, J. T., Fisher, G. R., & Dechenne-Peters, S. E. (2016). Development and Evaluation of the Tigriopus Course-Based Undergraduate Research Experience: Impacts on Students Content Knowledge, Attitudes, and Motivation in a Majors Introductory Biology Course. *Cell Biology Education*, *15*(4). doi:10.1187/cbe.15-11-0228

Olson, S., & Riordan, D. G. (2012). Engage to Excel: Producing one million additional college graduates with degrees in science, technology, engineering, and

mathematics. Report to the President. Executive Office of the President.

Paulsen, M. B., & Feldman, K. A. (1995). *Taking teaching seriously: Meeting the challenge of instructional improvement.* Washington, DC: George Washington University Press.

Perez, A. M., McShannon, J., & Hynes, P. (2012). Community college faculty development program and student achievement. *Community College Journal of Research and Practice, 36*(5), 379-385.

Posner, G. J., Strike, K. A., Hewson, P. W., & Gertzog, W. A. (1982). Accommodation of a scientific conception: Toward a theory of conceptual change. *Science Education, 66*(2), 211-227. doi:10.1002/sce.3730660207

Rask, K. (2010). Attrition in STEM fields at a liberal arts college: The importance of grades and pre-collegiate preferences. *Economics of Education Review, 29*(6), 892-900. doi:10.1016/j.econedurev.2010.06.013

Rau, M. A., Kennedy, K., Oxtoby, L., Bollom, M., & Moore, J. W. (2017). Unpacking "Active Learning": A Combination of Flipped Classroom and Collaboration Support Is More Effective but Collaboration Support Alone Is Not. *Journal of Chemical Education, 94*(10), 1406-1414. doi:10.1021/acs.jchemed.7b00240

Roehrig, G. H., Michlin, M., Schmitt, L., Macnabb, C., & Dubinsky, J. M. (2012). Teaching Neuroscience to Science Teachers: Facilitating the Translation of Inquiry-Based Teaching Instruction to the Classroom. *Cell Biology Education, 11*(4), 413-424. doi:10.1187/cbe.12-04-0045

Ruediger, W. C. (1911). *Agencies for the improvement of teachers in service. Bulletin of the United States Bureau of Education, no.3*. Washington: Government Printing Office.

Scott, T. P., Thigpin, S. S., & Bentz, A. O. (2017). Transfer learning community: Overcoming transfer shock and increasing retention of mathematics and science majors. *Journal of College Student Retention: Research, Theory & Practice, 19*(3), 300-316.

Shulman, G. M., Cox, M. D., & Richlin, L. (2004). Institutional considerations in developing a faculty learning community program. *New Directions for Teaching and Learning,* (97), 41-49.

Stes, A., Min-Leliveld, M., Gijbels, D., & Van Petegem, P. (2010). The impact of instructional development in higher education: The state-of-the-art of the research. *Educational Research Review, 5*(1), 25-49.

Steury, M. D., Poteracki, J. M., Kelly, K. L., Rennhack, J., & Wehrwein, E. A. (2016). Hypothesis-driven laboratories: An innovative way to foster learning in physiology laboratory courses. *Advances in Physiology Education, 40*(1), 129-133. 10.1152/advan.00095.2015

Sunal**,** D. W., Hodges, J., Sunal**,** C. S., Whitaker, K. W., Freeman, L. M., Edwards, L., Johnston, R. A., Odell, M. (2001). Teaching Science in Higher Education: Faculty Professional Development and Barriers to Change. *School Science and Mathematics, 101*(5), 246-257. doi:10.1111/j.1949-8594.2001.tb18027.x

Supovitz, J. A., & Turner, H. M. (2000). The effects of professional development on

science teaching practices and classroom culture. *Journal of Research in Science Teaching, 37*(9), 963-980. doi:10.1002/1098-2736(200011)37:93.0.co;2-0

Tanner, K. D. (2013). Structure matters: Twenty-one teaching strategies to promote student engagement and cultivate classroom equity. *CBE Life Sciences Education, 12*(3), 322-331. doi: 10.1187/cbe.13-06-0115

Tobias, S. (1992). *Revitalizing undergraduate science: Why some things work and most don't.* Tucson, AZ: Research Corporation.

Tovar, M., Jukier, R., Ferris, J., & Cardoso, K. (2015). Overcoming pedagogical solitude: The transformative power of discipline-specific faculty learning communities. *To Improve the Academy, 34*(1), 319-344.

Trigwell, K., & Prosser, M. (1996). Congruence between intention and strategy in university science teachers approaches to teaching. *Higher Education, 32*(1), 77-87. doi:10.1007/bf00139219

U.S. Department of Education. (2007). *Strategic plan for fiscal years 2007-12*. Washington, D.C., 2007.

Van Amburgh, J. A., Devlin, J. W., Kirwin, J. L., & Qualters, D. M. (2007). A tool for measuring active learning in the classroom. *American Journal of Pharmaceutical Education, 71(5)*, 1-8.

Van Ast, J., & Mullen, E. (1999). The Professional Development of Community College Applied Science and Technology Faculty. *The Journal of Technology Studies, 25*(1). doi:10.21061/jots.v25i1.a.3

Watts, G. E., & Hammons, J. O. (2002). Professional development: Setting the context.

New Directions for Community Colleges, 2002(120), 5-10. doi:10.1002/cc.83

Wilke, R. R. (2003). The effect of active learning on student characteristics in a human physiology course for nonmajors. *Advances in Physiology Education, 27*(4), 207-223. doi:10.1152/advan.00003.2002

Wilkerson, L., & Irby, D. M. (1998). Strategies for improving teaching practices. *Academic Medicine, 73*(4), 387-396. doi:10.1097/00001888-199804000-00011

Wongsopawiro, D. S., Zwart, R. C., & van Driel, J. H. (2017). Identifying Pathways of Teachers' PCK Development. Teachers and Teaching, 23(2) 191-210. doi: 10.1080/13540602.201601204286

Wright, J. C., Woods, R. C., Millar, S. B., Koscuik, S. A., Penberthy, D. L., Williams, P. H., Wampold, B. Wisconsin Univ., M. C. (1997). A Novel Comparative Assessment of Two Learning Strategies in a Freshman Chemistry Course for Science and Engineering Majors.

Yuretich, R. F. (2003). Encouraging critical thinking: Measuring skills in large introductory science classes. *Journal of College Science Teaching, 33*(3), 40-46.

Appendix

Appendix A

SURVEY PROTOCOLS

A.1 Science faculty

Faculty PD eval

Start of Block: Default Question Block

Q1 Rate the following statements about the New Faculty Development (NFD) program.

	Completely agree (1)	Somewhat agree (2)	Do not agree (3)
NFD introduces faculty to effective pedagogical skills in the classroom. (1)	○	○	○
NFD introduces faculty to new classroom technologies. (2)	○	○	○
	○	○	○
NFD directly assist faculty with	○	○	○

implementation of new learning strategies in the classroom. (4)

Q2 Faculty achieve competency by completing ... (select the best response)

- ○ the NFD program. (1)
- ○ the NFD program plus one other course. (2)
- ○ the NFD program plus more than one other course. (3)
- ○ the NFD program and taking any other beneficial course in the future. (4)
- ○ I do not agree with any of the above statements. (5)

Q3 Group the following professional development opportunities for instructional development in the desired box. (drag and drop)

Very beneficial for instructional development	Beneficial for instructional development	Not beneficial for instructional development
_____ Instructional innovation Network or professional organization conferences (1)	_____ Instructional innovation Network or professional organization conferences (1)	_____ Instructional innovation Network or professional organization conferences (1)
_____ College-wide in-service break-away sessions or Innovation Checkpoint (2)	_____ College-wide in-service break-away sessions or Innovation Checkpoint (2)	_____ College-wide in-service break-away sessions or Innovation Checkpoint (2)
_____ One-on-one CCIT training (please specify topics) (3)	_____ One-on-one CCIT training (please specify topics) (3)	_____ One-on-one CCIT training (please specify topics) (3)
_____ Face-to-face or online college-wide	_____ Face-to-face or online college-wide	_____ Face-to-face or online college-wide

workshops (please specify topics) (5)	workshops (please specify topics) (5)	workshops (please specify topics) (5)
_____ Portfolio presentation (6)	_____ Portfolio presentation (6)	_____ Portfolio presentation (6)
_____ Webinars or CCIT courses on pedagogy or technology (8)	_____ Webinars or CCIT courses on pedagogy or technology (8)	_____ Webinars or CCIT courses on pedagogy or technology (8)
_____ EPSCOR grant conference (11)	_____ EPSCOR grant conference (11)	_____ EPSCOR grant conference (11)
_____ Peer observation and feedback (4)	_____ Peer observation and feedback (4)	_____ Peer observation and feedback (4)

Q4 Rate how important each of the following is in promoting teacher training.(check all that apply)

	Very important (1)	Important (3)	Somewhat important (4)	Not important (5)
National efforts to promote science education (AAAS, NSF) (1)	○	○	○	○
The College effort (i.e., strategic plan) (2)	○	○	○	○
Information/assistance provided by CCIT/NFD (3)	○	○	○	○
Belonging to a teaching community or personal desire to improve skills (4)	○	○	○	○
Support by the Administration or promotion/advancement/recognition (5)	○	○	○	○
Helping prepare the next generation of young health-care professionals (7)	○	○	○	○

Insuring that all students are scientifically literate (8)	○	○	○	○

Q5 Rate how important the following skills are for science students.

	Very important (1)	Important (2)	Somewhat important (3)	Not important (5)
Scientific writing (1)	☐	☐	☐	☐
Memorize basic facts (2)	☐	☐	☐	☐
Acquire major scientific concepts (3)	☐	☐	☐	☐
Learn basic sets of laboratory skills (4)	☐	☐	☐	☐
Understand the dynamic nature of science (5)	☐	☐	☐	☐
Understand how science applies to everyday life (6)	☐	☐	☐	☐
Working in groups (7)	☐	☐	☐	☐
Remember formulas, structures, and procedures (8)	☐	☐	☐	☐

Q6 Rate how important the following instructional practices are in promoting student-centered learning.

	Very important (1)	Important (6)	Somewhat important (7)	Not important (8)
Communicating course goals and objectives to students (1)	○	○	○	○
Gauging students' background knowledge (2)	○	○	○	○
Using different types of teaching methods (3)	○	○	○	○
Using extensive lecturing (4)	○	○	○	○
Relating course material to real world applications (5)	○	○	○	○
Relating course material to scientific research (6)	○	○	○	○
Using different types of assessments for grades (7)	○	○	○	○
Using ungraded assessments to give students feedback (8)	○	○	○	○
Using an historic perspective (9)	○	○	○	○

--- For questions 7-13 pick a science course you have taught most frequently and with high enrollment.

Q7 Is this course a(n):

- ○ Majors (i.e., the course can satisfy any of our Allied Health or Nursing programs) (1)
- ○ Non-majors (i.e., the course satisfies any program NOT in Allied Health or Nursing) (2)
- ○ Elective (i.e., the course is not part of the major field, but can be used to satisfy credit requirements) (3)

Q8 Is this course a(n):

- ○ Prerequisite level course (needed to enter a program) (1)
- ○ Introductory level course (within the first year of program start) (2)
- ○ Upper-level course (within the last year of program completion) (3)

Q9 In what mode of instruction is this course given?

- ○ Lecture course (1)
- ○ Laboratory course (2)
- ○ Lecture and laboratory course (3)

Q10 What is the approximate enrollment of this course at your campus per year?

- ○ 20-60 students (1 to 3 sections) (1)
- ○ 60-100 students (3 to 6 sections) (2)
- ○ 100-200 students (5 to 10 sections) (3)
- ○ greater than 200 students (more than 10 sections) (4)

Q11 Do you try to learn about your students' academic or professional background?

- ○ Yes (1)
- ○ No (2)

Skip To: Q12 If Do you try to learn about your students' academic or professional background? = Yes

Skip To: Q13 If Do you try to learn about your students' academic or professional background? = No

Q12 Which methods do you use to learn about your students' background knowledge?

	Yes (1)	No (2)
Clicker questions (1)	○	○
Enrollment information (e.g., from Data reports or Institutional Research) (2)	○	○
Class discussions (3)	○	○
Individual discussions during office hours (4)	○	○
Pre-tests (5)	○	○

Other (please specify) (6)	○	○

Q13 In the undergraduate course that you just described, how often did you use each of the following practices?

	Every class session (1)	Most class sessions (9)	A few class sessions (10)	Once per semester (11)	Not at all (12)
Communicating course goals and objectives to students (1)	○	○	○	○	○
Group work during class time (including discussions, games, simulations, debates) (2)	○	○	○	○	○
Group work outside of class time (including Wikis, discussion boards, case studies) (3)	○	○	○	○	○
Extensive lecturing (lecturing more than 45 min. per class hour) (4)	○	○	○	○	○
In-class activities (reflective writing, journaling, graphic organizers,	○	○	○	○	○

data interpretation, clickers) (5)					
Online modules with immediate feedback (e.g. Mastering, Wiley Plus) (6)	○	○	○	○	○
Multimedia instruction (e.g. video clips, animations, sound clips) (7)	○	○	○	○	○

Q14 In the undergraduate course that you just described, have you used any of the following assessment tools?

	Do not use (1)	Use and counts toward student grade (2)	Use, but doesn't count toward student grade (3)
Multiple-choice or true/false questions (1)	○	○	○
Essay or short answer questions (2)	○	○	○
Quizzes, pretest, posttest (3)	○	○	○
Oral presentations, student posters mini research papers (4)	○	○	○
Student evaluations of each others work (5)	○	○	○
Portfolios, group projects, lab reports (6)	○	○	○

Class participation (clickers, games, mini quizzes) (7)	○	○	○
Other (please specify) (13)	○	○	○

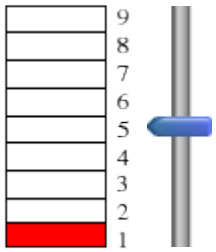
Q15 The professional development training through CCIT assisted me with the following:

	Yes (1)	No (2)
introduced me to innovative teaching practices/techniques (1)	○	○
assisted me with conducting research on my teaching (2)	○	○
helped me develop teaching methods appropriate for my class (3)	○	○
helped me develop or select assessments appropriate for my class (4)	○	○
provided me with ongoing support as I implement new teaching practices (5)	○	○
introduced me to a teaching community of my colleagues (6)	○	○

Q16 Please provide any professional development programs / topics that would help you with your teaching practice.

_____

Q17 Rate from 1-9 the satisfaction you derive from teaching. (1 = Not satisfied; 9 = Very satisfied)



1 (1)
2 (2)
3 (3)
4 (4)
5 (5)
6 (6)
7 (7)
8 (8)
9 (9)

Q18
Which courses do you predominantly teach during one academic year? (choose only those that apply)

	Usually one semester (1)	Usually both semesters (2)
Anatomy & Physiology (120/121) (1)	○	○
Chemistry (100, 110) (2)	○	○
Chemistry (111, 150, 151) (3)	○	○
Biology (140/150/151) (4)	○	○
Other Biology (5)	○	○
Other Chemistry (6)	○	○

Q19 Please indicate which of the following best describes your role at the college.

▼ Faculty (2) ... Clinical coordinator (5)

Q20 How many years have you been at Delaware Technical Community College as a faculty member?

▼ 0 - 3 (1) ... Over 10 (4)

Q21 Did you have teaching experience in higher education prior to coming to DTCC?

- ☐ Yes (1)
- ☐ No (2)

Skip To: Q22 If Did you have teaching experience in higher education prior to coming to DTCC? = Yes

Skip To: Q23 If Did you have teaching experience in higher education prior to coming to DTCC? = No

Q22 How many years?

- ○ 0 - 3 (1)
- ○ 4 - 6 (2)
- ○ 7 - 9 (3)
- ○ over 10 (4)

Q23 Estimate the percentage of time you spend on each of the following professional responsibilities. Please note that the categories should add up to 100%.

_____ Committees (1)
_____ Teaching and class administration (2)
_____ College administration (3)
_____ Community outreach (4)
_____ Recruitment (5)

End of Block: Default Question Block

A.2 CCIT staff

CCIT Staff survey

Start of Block: Default Question Block

Q1 Which statement(s) accurately describes the New Faculty Development (NFD) program.
(Check all that apply)

- ☐ NFD introduces faculty to effective pedagogical skills in the classroom. (1)
- ☐ NFD introduces faculty to new classroom technologies. (2)
- ☐ NFD introduces faculty to different. (3)
- ☐ NFD directly assist faculty with implementation of new learning strategies in the classroom. (4)
- ☐ Other (please specify) (5) _____

Q2
Faculty achieve competency by completing ... (select the best response)

NFD - New Faculty Development

- ○ the NFD program. (1)
- ○ the NFD program plus taking one other course. (2)
- ○ the NFD program plus taking more than one other course. (3)
- ○ the NFD program and taking any course determined to be beneficial in the future. (4)
- ○ I do not agree with any of the statements. (5)

Q3 Group the following professional development opportunities for instructional development in the desired box. (drag and drop)

Very beneficial for instructional development	Beneficial for instructional development	Not beneficial for instructional development
_____ Instructional innovation Network or professional organization conferences (1)	_____ Instructional innovation Network or professional organization conferences (1)	_____ Instructional innovation Network or professional organization conferences (1)
_____ College-wide inservice break-away sessions or Innovation Checkpoint (2)	_____ College-wide inservice break-away sessions or Innovation Checkpoint (2)	_____ College-wide inservice break-away sessions or Innovation Checkpoint (2)
_____ One-on-one CCIT training [(Please specify topic(s)] (3)	_____ One-on-one CCIT training [(Please specify topic(s)] (3)	_____ One-on-one CCIT training [(Please specify topic(s)] (3)
_____ Face-to-face or online college-wide workshops [(Please specify topic(s)] (4)	_____ Face-to-face or online college-wide workshops [(Please specify topic(s)] (4)	_____ Face-to-face or online college-wide workshops [(Please specify topic(s)] (4)
_____ Portfolio presentation (5)	_____ Portfolio presentation (5)	_____ Portfolio presentation (5)

_____ Webinars or CCIT courses on pedagogy or technology (6)	_____ Webinars or CCIT courses on pedagogy or technology (6)	_____ Webinars or CCIT courses on pedagogy or technology (6)
_____ Peer observation and feedback (7)	_____ Peer observation and feedback (7)	_____ Peer observation and feedback (7)

Q4 Rate how important each of the following is in promoting teacher training.

	Very important (1)	Important (2)	Somewhat important (3)	Not important (4)
National efforts to promote science teaching (AAAS, NSF) (1)	○	○	○	○
The College effort (i.e., strategic plan) (2)	○	○	○	○
Information/assistance provided by CCIT/NFD (3)	○	○	○	○
Belonging to a teaching community or personal desire to improve skills (4)	○	○	○	○
Support by the Administration or promotion / advancement / recognition (5)	○	○	○	○
Helping to prepare the next generation of young health-care professionals (6)	○	○	○	○
Insuring that all students are scientifically literate (7)	○	○	○	○

Q5 Rate how important each of the following skills are for science students.

	Very important (1)	Important (2)	Somewhat important (3)	Not important (4)
Scientific writing (1)	○	○	○	○
Memorize some basic facts (2)	○	○	○	○
Acquire major scientific concepts (3)	○	○	○	○
Learn basic sets of laboratory skills (4)	○	○	○	○
Understand the dynamic nature of science (5)	○	○	○	○
Understand how science applies to everyday life (6)	○	○	○	○
Remember formulas, structures, and procedures (7)	○	○	○	○

Q6 Rate how important the following instructional practices are to student-centered learning.

	Very important (1)	Important (2)	Somewhat important (3)	Not important (4)
Communicating course goals and objectives to students (1)	○	○	○	○
Group work during class time (including discussions, games, simulations, debates) (2)	○	○	○	○
Group work outside of class time (including Wikis, discussion boards, case studies) (3)	○	○	○	○
Extensive lecturing (lecturing more than 45 min. per class hour) (4)	○	○	○	○
In-class activities (Reflective writing/journaling, graphic organizers, data interpretation, clickers) (5)	○	○	○	○
Online module with immediate feedback (such as Mastering, Wiley Plus, etc.) (6)	○	○	○	○

Multimedia instruction (e.g., video clips, animations, sound clips) (7)	○	○	○	○

Q7 Pick the top five (5) instructional practices that promote student success in high enrollment / high attrition science courses. (drag and drop)

Top 5 instructional practices
_____ Communicating course goals and objectives (1)
_____ Engagement activities (clickers, games, role play, discussions/debates) (2)
_____ Out of class activities (discussion boards, Wikis) (3)
_____ Extensive lecturing (lecturing more than 45 min. per class hour) (4)
_____ In-class activities (reflective writing/journaling, graphic organizers, data interpretation, clickers) (5)
_____ Online module with immediate feedback (such as Mastering or Wiley Plus, etc.) (6)
_____ Multimedia instruction (video clips, animations, sound clips) (7)

Q8 Which training opportunities does CCIT offer?

- [ ] Communicating course goals and objectives to students (1)
- [ ] Group work during class time (including discussions, games, simulations, debates) (2)
- [ ] Group work outside of class time (including Wikis, discussion boards, case studies) (3)
- [ ] Extensive lecturing (more than 15 min per session) (4)
- [ ] In-class activities (Reflective writing/journaling, graphic organizers, data interpretation, clickers (5)
- [ ] Using online modules with immediate feedback (such as Mastering, Wiley Plus, etc.) (6)
- [ ] Multimedia instruction (e.g., video clips, animations, sound clips) (7)

Q9 Group the following assessment techniques that promote student-centered learning. (drag and drop)

Student-centered assessments
_____ Multiple-choice, true/false questions (1)
_____ Essay/short answer questions (2)
_____ Oral presentations, student posters (3)
_____ Student assessment of student work (4)
_____ Portfolios, group projects, lab reports, mini research papers (5)
_____ Class participation (6)
_____ Mid-semester student course evaluations of teaching (7)

_____ Pre-test of prior knowledge (8)

_____ Other (please specify) (9)

Q10 Which of the following topics on assessment techniques are offered in CCIT courses?

- [ ] Designing summative assessments (exams, quizzes) (1)
- [ ] Writing essay questions and rubrics (2)
- [ ] Assessing student posters or oral presentations (3)
- [ ] Rubric for student evaluations of student work (4)
- [ ] Other (please specify) (5) _____
- [ ] Assessing portfolios, group projects, lab reports, research papers (6)
- [ ] Mid-semester course evaluations regarding your teaching (7)
- [ ] Pre-testing of prior knowledge (8)
- [ ] Assessing class participation (9)

Q11 Provide any professional development practices / topics **NOT** currently offered by CCIT that would benefit science faculty?

_____

_____

_____

_____

_____

Q12 In which department do you teach during one academic year? (please choose all that apply)

- ☐ Science, Nursing, Allied Health or Engineering (1)
- ☐ English or Humanities (2)
- ☐ Math or Business (3)
- ☐ Arts (4)
- ☐ Student support courses (SSC) (5)
- ☐ None (6)

Skip To: Q14 If In which department do you teach during one academic year? (please choose all that apply) = None

Q13 Rate the level of satisfaction you get from teaching.

▼ Very satisfied (1) ... Not satisfied (4)

Q14 Which of the following best describes your role at the college.

- ○ CCIT administration (1)
- ○ Educational technologist (2)
- ○ Instructional designer (3)
- ○ Learning strategies coordinator (4)
- ○ Media services/production (5)

Q15 How many years have you been at Delaware Technical Community College?

▼ 0 - 3 (1) ... Greater than 10 (4)

Q16 Did you have teaching experience in higher education prior to coming to DTCC?

- ○ Yes (1)
- ○ No (2)

Skip To: Q17 If Did you have teaching experience in higher education prior to coming to DTCC? = Yes

Skip To: End of Survey If Did you have teaching experience in higher education prior to coming to DTCC? = No

Q17 If yes, how many years?

▼ 0 - 3 (1) ... Greater than 10 (4)

End of Block: Default Question Block

A.3 Science Department Chairs

Dept Chair PD eval

Start of Block: Default Question Block

Q1 On average, how often do you observe your science faculty in the classroom or laboratory?

- ☐ Once per year (1)
- ☐ Twice per year (2)
- ☐ More than twice per year (3)

Q2 Which of the following best describes your observations?

- ○ Most of the instruction was delivered in a lecture format. (1)
- ○ The instruction was mostly lecture-based with some student engagement activities. (2)
- ○ The instruction was an equal mixture of lecture and engagement activities. (3)
- ○ The instruction was mainly conducted using active learning based on foundation lecturing. (4)

Skip To: Q3 If Which of the following best describes your observations? = The instruction was mostly lecture-based with some student engagement activities.

Skip To: Q3 If Which of the following best describes your observations? = The instruction was an equal mixture of lecture and engagement activities.

Skip To: Q3 If Which of the following best describes your observations? = The instruction was mainly conducted using active learning based on foundation lecturing.

Q3 Please choose all of the following techniques you observed being used. (check all that apply)

- ☐ Cooperative learning / group discussions (1)
- ☐ Data analysis (2)
- ☐ Simulations (3)
- ☐ Problem-based learning / case studies (4)
- ☐ Question creation (5)
- ☐ Concept maps (6)
- ☐ Other (7) _____

Q4 Group the following **observed** instructional strategies as "used effectively" or "needs improvement". (drag and drop)

Used effectively	Requires improvement
_____ Presentation (1)	_____ Presentation (1)
_____ Lecture organization (2)	_____ Lecture organization (2)
_____ Lecture content (3)	_____ Lecture content (3)
_____ Student interaction (4)	_____ Student interaction (4)
_____ Student engagement (5)	_____ Student engagement (5)
_____ Assessments (6)	_____ Assessments (6)

Q5 Group the following professional development opportunities for instructional development in the desired box. (drag and drop)

Very beneficial for instructional development	Beneficial for instructional development	Not beneficial for instructional development
_____ Instructional Innovation Network or professional organization conferences (1)	_____ Instructional Innovation Network or professional organization conferences (1)	_____ Instructional Innovation Network or professional organization conferences (1)
_____ College-wide inservice break-away sessions or Innovation Checkpoint (2)	_____ College-wide inservice break-away sessions or Innovation Checkpoint (2)	_____ College-wide inservice break-away sessions or Innovation Checkpoint (2)
_____ One-on-one CCIT training [(Please specify topic(s)] (3)	_____ One-on-one CCIT training [(Please specify topic(s)] (3)	_____ One-on-one CCIT training [(Please specify topic(s)] (3)
_____ Face-to-face or online college-wide workshops [(Please specify topic(s)] (4)	_____ Face-to-face or online college-wide workshops [(Please specify topic(s)] (4)	_____ Face-to-face or online college-wide workshops [(Please specify topic(s)] (4)
_____ Portfolio presentation (5)	_____ Portfolio presentation (5)	_____ Portfolio presentation (5)
_____ Webinars or CCIT courses on pedagogy or technology (6)	_____ Webinars or CCIT courses on pedagogy or technology (6)	_____ Webinars or CCIT courses on pedagogy or technology (6)
_____ Peer observation and feedback (7)	_____ Peer observation and feedback (7)	_____ Peer observation and feedback (7)

Q6 Which of the following professional development topics do you believe should be mandatory training for all science faculty? (Please check all that apply)

	Mandatory (1)	Optional (2)
Instructional Innovation Network or professional organization conferences (1)	○	○

College-wide inservice break-away sessions or Innovation Checkpoint (2)	○	○
One-on-one CCIT training (3)	○	○
Face-to-face or online college-wide workshops (4)	○	○
Portfolio presentation (5)	○	○
Webinars or CCIT courses on pedagogy or technology (6)	○	○
Peer observation and feedback (7)	○	○

Q7 Rate how important each of the following is in promoting teacher training.Please check all that apply)

	Very important (1)	Important (2)	Somewhat important (3)	Not important (4)
National efforts to promote science teaching (AAAS, NSF) (1)	○	○	○	○
The College effort (i.e., strategic plan) (2)	○	○	○	○
Information/assistance provided by the CCIT/NFD (3)	○	○	○	○
Belonging to a teaching community or personal desire to improve skills (4)	○	○	○	○
Support by the Administration or promotion/advancement/recognition (5)	○	○	○	○

Helping to prepare the next generations of young health-care professionals (6)	○	○	○	○
Insuring that all students are scientifically literate (7)	○	○	○	○

Q8 Rate how important the following skills are for science students.

	Very important (1)	Important (2)	Somewhat important (3)	Not important (4)
Scientific writing (1)	○	○	○	○
Memorize some basic facts (2)	○	○	○	○
Acquire major scientific concepts (3)	○	○	○	○
Learn basic sets of laboratory skills (4)	○	○	○	○
Understand the dynamic nature of science (5)	○	○	○	○
Understand how science applies to everyday life (6)	○	○	○	○
Remember formulas, structures, and procedures (7)	○	○	○	○

Q9 Rate how important the following instructional practices are to student-centered learning.

	Very important (1)	Important (2)	Somewhat important (3)	Not important (4)
Communicating course goals and objectives to students (1)	○	○	○	○
Group work during class time (including discussions, games, simulations, debates) (2)	○	○	○	○
Group work outside of class time (including Wikis, discussion boards, case studies) (3)	○	○	○	○
Extensive lecturing (lecturing more than 45 min. per class hour) (4)	○	○	○	○
In-class activities (reflective writing/journaling, graphic organizers, data interpretation, clickers (5)	○	○	○	○
Online module with immediate feedback (such as Mastering, Wiley Plus, etc.) (6)	○	○	○	○

Multimedia instruction (e.g. video clips, animations, sound clips) (7)	○	○	○	○

Q10 How important is learning about students' backgrounds to providing a learner-centered environment?

▼ Very important (1) ... Not important (4)

Q11 Pick the top five (5) instructional practices that promote student success in a high enrollment / high attrition science course. (drag and drop)

Top 5 instructional practices
_____ Communicating course goals and objectives to students (1)
_____ Engagement activities (clickers, games, role play, discussions/debates) (2)
_____ Out of class activities (discussion boards, Wikis) (3)
_____ Extensive lecturing (less than 15 min per lecture hour for engagement) (4)
_____ Reflective writing/journaling, graphic organizers, data interpretation (5)
_____ Online module with immediate feedback (such as Mastering) (6)
_____ Real-life problems (e.g., Problem-Based Learning, case studies) (7)
_____ Multimedia instruction (e.g., video clips, animations, sound clips) (8)
_____ Answering questions from individual students in class (9)

Q12 Choose all the following assessments that promote student-centered learning? (drag and drop)

Student-centered assessments
_____ Multiple-choice, true/false questions (1)
_____ Essay/short answer questions (2)
_____ Quizzes, pre-test, post-test (3)
_____ Oral presentations, student posters, mini research papers (4)
_____ Student evaluations of each others' work (5)
_____ Portfolios, group projects, lab reports (6)
_____ Class participation (7)
_____ Mid-semester course evaluations regarding your teaching (8)
_____ Other (please specify) (9)

Q13 What kinds of professional development programs / topics would you like to see offered? (Please provide any topics, courses or technology of interest)

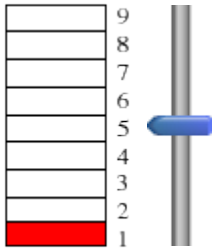
_____

Q14
Which course(s) do you teach during one academic year?

- [ ] Anatomy & Physiology (120/121) (1)
- [ ] Chemistry (2)
- [ ] Biology (3)
- [ ] None (4)
- [ ] Other courses (5)

Skip To: Q16 If Which course(s) do you teach during one academic year? = None

Q15 Rate from 1-9 the satisfaction you derive from teaching. (1 = Not satisfied; 9 = Very satisfied)



1 (1)
2 (2)
3 (3)
4 (4)
5 (5)
6 (6)
7 (7)
8 (8)
9 (9)

Q16 How many years have you been at Delaware Technical Community College as a faculty / Chairperson member?

▼ 0 - 3 (1) ... Over 10 (4)

Q17 Did you have teaching experience in higher education prior to coming to DTCC?

- [ ] Yes (1)
- [ ] No (2)

Skip To: Q18 If Did you have teaching experience in higher education prior to coming to DTCC? = Yes

Skip To: Q19 If Did you have teaching experience in higher education prior to coming to DTCC? = No

Q18 How many years?

- ○ 0 - 3 (1)
- ○ 4 - 6 (2)
- ○ 7 - 9 (3)
- ○ over 10 (4)

Q19 Estimate the percentage of time you spend on each of the following professional responsibilities. Please note that the categories should add up to 100%.

_____ Committees (1)
_____ Teaching and class administration (2)
_____ College administration (3)
_____ Community outreach (4)
_____ Recruitment (5)

End of Block: Default Question Block

Appendix B

INSTITUTIONAL RESEARCH BOARD

B.1 DTCC – Research Approval Request

Statement of the Problem

One of Delaware Tech's mission goals states that college programs, activities, and services will cultivate student learning and success. To that end, Delaware Tech has initiated their ***strategic directions*** to respond to external environmental trends, which include transforming learning spaces to accommodate collaborative learning and advance the delivery of innovative instructional offerings. The above directions support one aspect of the college's vision: creating an institution dedicated to providing instructional practices and high-impact engagement strategies to support student success.

A report from the American Association for the Advancement of Science (AAAS) (Vision, 2010, p. 21) recommends educators to incorporate active learning practices in the classroom, and by doing so, satisfy a crucial element for effective science education. Numerous studies have identified effective teaching and learning practices. In higher education, instruction is still being conducted in a traditional, lecture-based fashion due to a variety of reasons (Henderson and Dancy, p. 3; 2011; Hativa, 1993, p. 591). At Delaware Technical Community College students focusing on the allied health or nursing fields are required to take prerequisite courses in biology and chemistry to be accepted into their desired field of study. College data shows that the average attrition rate for the entry-level biology and chemistry courses is higher than other courses offered at the college.

These concerns point to a link between the ability of science faculty to provide effective classroom pedagogy, and fostering student persistence in science courses, and enhancing student success in the science fields. Therefore, determining that science faculty are both trained in and implementing effective student-centered instruction, resulting in positive outcomes, should be a

concern for Delaware Tech's professional development program. The purpose of this proposed project is to identify what learner-centered pedagogies are being used by the science faculty at DTCC and what, if any, appropriate professional development improvements need to be considered for the science faculty at DTCC.

Purpose of the study

The purpose of this proposed project is to identify what learner-centered pedagogies are being used by the science faculty at DTCC and what, if any, appropriate professional development improvements need to be considered for the science faculty at DTCC. As science faculty improve their pedagogical skills, students in the allied health and nursing programs would experience greater success and graduate sooner. Other benefits would include reducing the number of students transferring to other institutions, withdrawing from the college, and increasing the number of student graduates.

Understanding what pedagogical requirements the science faculty regard as being important to student success will better inform the college and CCIT of the future professional development support that science faculty require. With the altered professional development curriculum faculty instruction would improve with the concomitant rise in student retention and completion.

Key questions

What active learning skills do science faculty believe are essential for effective science education?

What pedagogical skills are science faculty utilizing in the classroom?

What active learning strategies are Science Department Chairs reporting in their classroom observations of faculty?

What active learning pedagogies are being offered by CCIT that promote science education?

Project Design

The process-outcomes evaluation design proposed here will be to identify which program components are considered central to science faculty and PD staff in terms of providing effective

instructional strategies. The evaluation will also be able to note which program components the faculty completed, whether the training was transformative and whether the transformation was exhibited in the classroom. The program staff will identify what program items they perceive to be germane to the program goals and if any of their offerings would also be relevant to science faculty.

The outcomes evaluation will be using a one-group design gathering data from the after-only sample population (Weiss, 1998, p. 191). The methodological design will be to gather quantitative and qualitative data from several sources. The quantitative data will be provided from three survey instruments using a combination of ordinal and nominal measure questions (Weiss, 1998, p. 182). The qualitative data will be generated from two sources: the open-ended questions from the survey and the review of student evaluation reports (Weiss, 1998, p. 260). Indicators of faculty using student-centered instructional methodologies can also come from historical records by reviewing student evaluations (Weiss, 1998, p. 192). Student evaluations less than two years old retain both the student comments and the Likert-scale responses. Student evaluations older than two years are missing the Likert-scale responses but still retain the student comments.

There will be data collected from four sources: full time science faculty from all four campuses, Department chairs from the same campuses, CCIT staff and administrators directly involved in curriculum design (course content, technology testing, peer observations), and archived student evaluation reports of the same faculty surveyed from the last two academic years. Anonymous surveys to the three groups of stakeholders will be utilized, with survey questions being similar in nature. The general theme of each survey is to answer the question of whether the development activities provided to science faculty have been utilized in the classroom. The length of the survey instruments were modified to distinguish between respondents that deliver the training (PD staff survey), respondents that rate the faculty use of training (Department chairperson survey), and respondents that complete the training (Science faculty survey).

The quantitative data will be collected from Likert-scale and multiple choice questions from the surveys. Comparisons of the data using ANOVA, and t-tests statistical analyses will be used to make conclusions (Marbach-Ad 2014, p. 236). The multiple analysis of variance (multiple ANOVA) will be used to compare beliefs of effective teaching skills between and within the groups (science faculty, department chairs, CCIT staff) (Graveter, 2016, p. 458). If a difference in beliefs between or within groups is identified as significant, a one-factor ANOVA will be determined (Marbach-Ad 2014, p. 369). Tukey's Honestly Significant Difference (HSD) test will be used to identify the minimum difference between means to achieve significance (Marbach-Ad 2014, p. 394). Use of the Spearman correlation will allow the analysis of the

ordinal ranking questions between the different populations (Marbach-Ad 2014, p. 510). The analyzed results will be depicted as both means and percentages. This will underscore the differences observed from the data between the groups.

The archived electronic student evaluation reports will be reviewed using two formats. A sample of comments from the open-ended questions will be used to generate a theme of instructor characteristics and use of effective teaching practices. Statements like "reads the slide", "keeps things interesting", will be used to identify effective use of learning practices. Responses to specific evaluation questions, identifying the effective use of learning practices by the instructor, will also be pulled out of the archived data.

Utilization of College Resources

This project will require access to the student evaluation reports for all active full time faculty. Instructor identities will remain anonymous, and every effort will be made to ensure that student comments will not be linked in any way to instructor identities. Data acquisition will take approximately 2-4 hours by the campus Data Manager, Jason Cox.

Use of Subjects

There will be data collected from three subject sources: full time science faculty from all four campuses, Department chairs from the same campuses, and CCIT staff and administrators directly involved in professional development curriculum design (course content, technology testing, peer observations). Anonymous surveys to the three groups of stakeholders will be sent by Survey Monkey. The exact number of subjects is not confirmed, but approximately 13 CCIT staff, 4 science chairs, 20-30 science faculty.

Recruitment

The subjects' email addresses will be collected from the college website or from the college/campus phone directory. The selection process is based on only one criterion; all the subjects must be associated with the science department or CCIT. Survey monkey is a free service except possibly to the survey designer.

Data Storage & Disposition

The survey data will be stored in accordance with the policies of the University of Delaware. Consent forms will be secured, with the originals stored on campus; separate from other data and file linking names and id numbers/pseudonyms in a locked filing cabinet or in an encrypted electronic folder.

Storage of Data on CEHD/OET Server

Human subjects research data will be stored and secured on the University of Delaware CEHD/SOE Server. Off campus access to the server will be through the Virtual Private Network (VPN). To apply for an OET user account, the faculty member should write to oet-help@udel.edu to request an account. If the request is for a student account, the faculty advisor should request the account through oet-hep@udel.edu and copy the student on the e-mail with the student's UD e-mail address. It is important to indicate whether or not faculty advisor would have access to student OET files. Faculty advisors should indicate (by writing to oet-help@udel.edu) when data and records on the CEHD/SOE server can be deleted.

Data Storage After Research is Complete (Closed Projects)

A copy of research records (e.g., consents, data, approval for initial protocol, amendments, continuing review) must be available for 3 years following the close of the project and available on campus. Original copies of consent/assent forms should be retained on campus. Records can be sent to the Research Office to be stored in University archives.

Data Storage for Projects of Faculty or Students Who Leave UD

A copy of research records (e.g., consents, data, approval for initial protocol, amendments, continuing review) must be available for 3 years following the close of the project and available on campus. Original copies of consent/assent forms should be retained on campus. Faculty advisors (or other supervisors) are responsible for storing data records or data records can be sent to the University Archives for storage. Records sent to the University Archives can be labeled with a "destroy by" date, if appropriate. For example, if the project ended on 10/1/12, then the "destroy by" date could stipulate that the research records for the project could be destroyed on or after 10/1/15.

Students or faculty members who leave UD and take a copy of the data with them are responsible for maintaining the same levels of data security. As soon as possible and to the extent possible, the file linking names to id numbers/pseudonyms should be destroyed and all identifiers removed from research records. Data on servers will be deleted and scrubbed (secure erase) according to University of Delaware protocol. Data on flash drives will be deleted, scrubbed, and then physically destroyed (secure erase) according to University of Delaware protocol.

Confidentiality and Consent

All data will be anonymous due to the nature of the project. Surveys will be sent out anonymously, with no campus identification in the surveys. Supervisor and CCIT staff anonymity will be maintained within the survey because those functions on the survey are combined into one function.

References

Gravetter, F. J., & Wallnau, L. B. (2015). Statistics for the behavioral sciences (10th ed.). 20 Channel Center Street, Boston, MA, 02210: Cengage Learning.

Hativa, N. (1993). Attitudes towards instruction of faculty in mathematics and the physical sciences. International Journal of Mathematical Education in Science and Technology, 24(4), 579-593.

Henderson, C., & Dancy, M. H. (2011). Increasing the impact and diffusion of STEM education innovations. Invited Paper for the National Academy of Engineering, Center for the Advancement of Engineering Education Forum, Impact and Diffusion of Transformative Engineering Education Innovations.

Marbach-Ad, G., Ziemer, K. S., Orgler, M., & Thompson, K. V. (2014). Science teaching beliefs and reported approaches within a research university: Perspectives from faculty, graduate students, and undergraduates. International Journal of Teaching and Learning in Higher Education, 26(2), 232-250.

Vision and change: A call to action. (2010). (No. 1). Washington, DC: AAAS.

Weiss, C. H. (1998). Evaluation : Methods for studying programs and policies (2nd ed.). Upper Saddle River, N.J.: Prentice Hall.

B.2 CITI Program – Human subjects certification

CITI PROGRAM

Completion Date 18-Jun-2017
Expiration Date 18-Jun-2018
Record ID 23598112

This is to certify that:

Alfred Noubani

Has completed the following CITI Program course:

Human Subjects Research - BASIC (Curriculum Group)
Human Subjects Research – IRB - Social-Behavioral-Educational Focus (Course Learner Group)
1 - Independent Learner (Stage)

Under requirements set by:

Independent Learner

CITI

Verify at www.citiprogram.org/verify/?wf78266c1-782f-42c9-bd26-c97207c60b7f-23598112

B.3 Exemption letter

RESEARCH OFFICE

210 Hullihen Hall
University of Delaware
Newark, Delaware 19716-1551
Ph: 302/831-2136
Fax: 302/831-2828

DATE: July 21, 2017

TO: Alfred Noubani, M.S.
FROM: University of Delaware IRB

STUDY TITLE: [1099740-1] Improving Faculty Professional Development for Community College Science Educators

SUBMISSION TYPE: New Project

ACTION: DETERMINATION OF EXEMPT STATUS
DECISION DATE: July 21, 2017

REVIEW CATEGORY: Exemption category # *(2)*

Thank you for your submission of New Project materials for this research study. The University of Delaware IRB has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will put a copy of this correspondence on file in our office. Please remember to notify us if you make any substantial changes to the project.

If you have any questions, please contact Nicole Farnese-McFarlane at (302) 831-1119 or nicolefm@udel.edu. Please include your study title and reference number in all correspondence with this office.

Generated on IRBNet

B.4 Human Subjects Protocol

HUMAN SUBJECTS PROTOCOL
University of Delaware

Protocol Title:
Improving Faculty Professional Development for Community College Science Educators

Principal Investigator
Name: Alfred Noubani
Department/Center: College of Education and Human Development
Contact Phone Number: 302-857-1319
Email Address: anoubani@dtcc.edu

Advisor (if student PI):
Name: Dr. Fred Hofstetter
Contact Phone Number: 302-831-8164
Email Address: fth@udel.edu

Other Investigators:

Investigator Assurance:

By submitting this protocol, I acknowledge that this project will be conducted in strict accordance with the procedures described. I will not make any modifications to this protocol without prior approval by the IRB. Should any unanticipated problems involving risk to subjects occur during this project, including breaches of guaranteed confidentiality or departures from any procedures specified in approved study documents, I will report such events to the Chair, Institutional Review Board immediately.

1. **Is this project externally funded?** ☐ YES ☑ NO

If so, please list the funding source:

2. Research Site(s)

☐ University of Delaware

☑ Other (please list external study sites) Delaware Technical Community College

Is UD the study lead? ☑ YES ☐ NO (If no, list the institution that is serving as the study lead)

3. **Project Staff**
Please list all personnel, including students, who will be working with human subjects on this protocol (insert additional rows as needed):

NAME	**ROLE**	**HS TRAINING COMPLETE?**
Alfred Noubani	PI	Yes

4. **Special Populations**
Does this project involve any of the following:

Research on Children? No

Research with Prisoners? No

If yes, complete the Prisoners in Research Form and upload to IRBNet as supporting documentation

Research with Pregnant Women? No

Research with any other vulnerable population (e.g. cognitively impaired, economically disadvantaged, etc.)? please describe

No

5. **RESEARCH ABSTRACT** Please provide a brief description in LAY language (understandable to an 8th grade student) of the aims of this project.

To see what science teachers do in class and what they need to improve. This will take asking questions to people involved in helping science teachers give students a better learning experience. The questions will be asked to three groups of people. The first group are the science teachers; they will be asked to describe what they do in the classroom and what they think would help them do a better job. The second group are the teacher helpers or trainers; they will be asked to explain what they do to help science teachers make the classroom a better place for students to learn. The third group are the teachers' supervisor; they will be asked to describe what they see during a classroom observation and what they think good teaching looks like.

6. **PROCEDURES** Describe all procedures involving human subjects for this protocol. Include copies of all surveys and research measures.

The procedures will be in the form of three surveys. Each group of participants will be sent an electronic survey to be completed anonymously. The survey questions contain Likert style questions, open-ended questions, and some demographic questions.

7. **STUDY POPULATION AND RECRUITMENT**
Describe who and how many subjects will be invited to participate. Include age, gender and other pertinent information.

The three groups of subjects are the science faculty, the science department chairs and the professional development staff and administrators from the four campuses of Delaware Technical Community College. There will be about 51 subjects that will participate. All subjects are over 21 yr old, from diverse ethnic and cultural backgrounds including all identified genders.

Attach all recruitment fliers, letters, or other recruitment materials to be used. If verbal recruitment will be used, please attach a script.

All participants will be sent an email with the following message.

Dear Colleague,

I am in the process of completing my doctoral degree in education at the University of Delaware and my final project is to conduct a study on the professional development training options for science faculty. The results of this study will be used to inform CCIT of my findings and offer recommendations for improvement to better serve the science faculty in their classroom pedagogical skills.

This survey focuses on teaching philosophies, practices, and how CCIT can accommodate science faculty by offering science-appropriate professional development topics and technology

strategies. This survey is anonymous and should take no more than 10-15 minutes to complete. I recognize that answering thoughtfully requires the investment of your time, and so I want to assure you that every effort will be made to relay the recommendations to CCIT staff and college administrators so that future improvements will be made to the program. If you have any questions please feel free to contact me at Alfred Noubani, anoubani@dtcc.edu.

Thank you for your time and consideration.
Fred Noubani

The following statement will be included with the department chair survey.

Definition of student-centered learning: a process whereby students engage in activities (reading, writing, discussion, problem solving) that promote analysis, synthesis, and evaluation of class content.

Student-centered activities: Cooperative learning, problem-based learning, case studies, concept maps, data analysis, question creation, group / class discussion, and simulations.

The following is a description of goals from CCIT professional development (IDT) courses.
- improve existing lesson plans, incorporate professional and field-specific resources, and teach using advanced methods and techniques.

- leverage appropriate technologies to promote student-centered, active learning: develop strategies and skills to effectively integrate social media, emerging, and synchronous technologies into instruction

- fundamental elements of the flipped classroom learning model: explore key principles, examine design challenges, develop effective learning activities and assessments

Describe what exclusionary criteria, if any will be applied.

The principal investigator will be excluded since he is a member of one of the groups. The faculty from the same campus as the principal investigator will be excluded due to research policies from Delaware Technical Community College prohibiting research on employees you supervise.

Describe what (if any) conditions will result in PI termination of subject participation.

The exclusion of Terry Campus science faculty will only reduce the total number of participants, but will not affect the overall outcomes.

8. **RISKS AND BENEFITS**
List all potential physical, psychological, social, financial or legal risks to subjects (risks listed here should be included on the consent form).

Potential risks would be if college administrators recognize any of the faculty from student evaluation data showing poor classroom performance.

In your opinion, are risks listed above minimal* or more than minimal? If more than minimal, please justify why risks are reasonable in relation to anticipated direct or future benefits.

Risks are considered minimal. Instructor performance is continually developing and improving. The college provides training in classroom conduct and instructional improvement, so any risks would be met with subsequent plans of improvement.

*(*Minimal risk means the probability and magnitude of harm or discomfort anticipated in the research are not greater than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests)*

What steps will be taken to minimize risks?

The principal investigator will review all documents carefully to ensure any instructor identification is absent. Instructor identifiers excluded from the data and results will be campus location, course identification, faculty quotes, and any other identifiers.

Describe any potential direct benefits to participants.

Benefits would come at a later date when changes to the professional development program are implemented.

Describe any potential future benefits to this class of participants, others, or society.

Participants may receive improved professional development opportunities that would enhance their teaching experience and create an improved working environment with the outcome of increased student success.

If there is a Data Monitoring Committee (DMC) in place for this project, please describe when and how often it meets.

None.

9. **COMPENSATION**
Will participants be compensated for participation?

No compensation is permitted due to policies from Delaware Technical Community College.

If so, please include details.

10. **DATA**
Will subjects be anonymous to the researcher?

Subjects will be known to the researcher only for the original dispersal of surveys, but survey results will be returned to the researcher anonymously.

If subjects are identifiable, will their identities be kept confidential? (If yes, please specify how)

Survey responses will be returned to the investigator anonymously using the Survey Monkey option. Any identifiable comments in the open-ended questions will be removed of the identifying word or phrase or completely omitted from the report.

How will data be stored and kept secure (specify data storage plans for both paper and electronic files. For guidance see http://www.udel.edu/research/preparing/datastorage.html)

All digital records (e.g., electronic files, digital recordings, etc.) containing human subjects research data will be stored and encrypted on the University of Delaware server or stored on a password protected portable flash drive. Any paper records will be stored in a locked cabinet within a locked office.

How long will data be stored?

Data is retained for three years after the study is complete.

Will data be destroyed? ☑ YES □ NO (if yes, please specify how the data will be destroyed)

All paper records will be shredded. Files on the University of Delaware server will be securely deleted (scrubbed). Portable memory drives will be physically destroyed once all the files are securely deleted (scrubbed).

Will the data be shared with anyone outside of the research team? ☐ YES ☑ NO (if yes, please list the person(s), organization(s) and/or institution(s) and specify plans for secure data transfer)

How will data be analyzed and reported?

Data will be analyzed using statistical analyses. The reported results will be in the form of percentages and means. There will also be a short section on student comments about

teaching experiences and a section on faculty comments on proposed professional development topics. The final results will be reported in a doctoral thesis and a college report on professional development improvements.

11. **CONFIDENTIALITY**
Will participants be audiotaped, photographed or videotaped during this study?

NO

How will subject identity be protected?

All surveys are electronic and anonymous. Data will be downloaded and saved onto a spreadsheet form for analysis with all possible descriptors removed.

Is there a Certificate of Confidentiality in place for this project? (If so, please provide a copy).

No

12. **CONFLICT OF INTEREST**
(For information on disclosure reporting see:
http://www.udel.edu/research/preparing/conflict.html)

Do you have a current conflict of interest disclosure form on file through UD Web forms?

No

Does this project involve a potential conflict of interest*?

No, Delaware Technical Community College policy prohibits me from conducting any research study with faculty or staff that I supervise.

* As defined in the University of Delaware's Policies and Procedures ,a potential conflict of interest (COI) occurs when there is a divergence between an individual's private interests and his or her professional obligations, such that an independent observer might reasonably question whether the individual's professional judgment, commitment, actions, or decisions could be influenced by considerations of personal gain, financial or otherwise.

If yes, please describe the nature of the interest:

13. **CONSENT and ASSENT**

__**YES**__ Consent forms will be used and are attached for review (see Consent Template under Forms and Templates in IRBNet)

Consent form Attached

____ Additionally, child assent forms will be used and are attached.

____ Waiver of Documentation of Consent (attach a consent script/information sheet with the signature block removed).

____ Waiver of Consent (Justify request for waiver)

14. **Other IRB Approval**
Has this protocol been submitted to any other IRBs?

No.

If so, please list along with protocol title, number, and expiration date.

15. **Supporting Documentation**
Please list all additional documents uploaded to IRBNet in support of this application.

Surveys, Informed Consent forms