A CASE STUDY OF THE PHYSICS ENHANCEMENT PROJECT FOR TWO YEAR COLLEGES, ITS EFFECTS AND OUTCOMES ON THE TEACHING OF UNDERGRADUATE PHYSICS AT TWO YEAR COLLEGES.

by

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B.A., Hastings College, Hastings, NE, 1984
M.A.T., Hastings College, Hastings, NE, 1989

AN ABSTRACT OF A DISSERTATION

Submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Curriculum and Instruction
College of Education

KANSAS STATE UNIVERSITY
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2008

Abstract

This dissertation reports on a naturalistic evaluation study of a series of NSF grant projects collectively known as PEPTYC -- Physics Enhancement Project for Two Year College Physics Instructors. The project encompassed seven different cycles of professional development occurring during the 1990's via May Institutes, held at Texas A&M University. Follow-up meetings were held at American Association of Physics Teachers - Texas Section Meetings. The research was conducted post hoc. The research evaluated the characteristics of effective professional development under an evaluation frame work designed by D.L. Kirkpatrick (1959) and adapted by the researcher to address issues that are pertinent to the professional development of faculty. This framework was adapted to be viewed through an educator's eye in an effort to ascertain the long term affects of the program and determine how the program affected the participants' attitudes, pedagogical knowledge, and instructional practices. The PEPTYC program philosophy was based on the premise, supported by research, that professional development programs addressing specific teaching practices are more successful than generic programs. Furthermore, professional development is more effective in helping teachers use alternative approaches when teachers are engaged in active learning experiences rather than passively listening to lectures or presentations. The naturalistic study was based on surveys and semi-structured interviews with 14 individuals who participated in PEPTYC workshops, as well as presenters of the PEPTYC program. The interviews were analyzed to describe how the PEPTYC project influenced the participants long after they had completed their training. This project can inform the development of similar evaluation studies of other professional development programs.

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Dedication

This work is dedicated to:

Robert D. Leif, the man who was my father. You were a high school graduate, a farmer, and my financial supporter during my undergraduate college experiences. You were a person who was admired by all who knew you. You got sick with cancer during my first sabbatical leave when I started this whole process. Although you didn't make it to see the final product, your eyes were always upon me as I typed, read, and watched my family grow during this whole process. God bestowed upon you the ability to teach me the lessons of life. You have instilled in me the ethics of hard work, honesty, and the value of being a public servant to teach others too. I hope and pray that I will always find happiness and contentment in my life pursuits and never cease to be appreciative or take for granted the gifts that God has bestowed upon me, because of mom's and your efforts. As each day passes I become more and more like you, proud, strong, and admired for my discipline. I will always remember the lessons learned from you, my father.

CHAPTER 1: INTRODUCTION

Deep change differs from incremental change in that it requires new ways of thinking and behaving. It is change that is major in scope, discontinuous with the past and generally irreversible.

---- Robert Quinn (1996)

Robert Quinn's words capture the essence of how many science education professionals view the role of change in our ever changing teaching profession. His vision of change in teaching and learning science is philosophically compelling. The task of creating a scientifically literate society places its mark on the lives of everyday citizens across our technologically advancing world. The learning goals for schools have undergone major changes during the past century. Stakeholders expect much more from today's schools than was expected 100 years ago. For example, "Science content increases and changes, and a teacher's understanding in science must keep pace." (NRC, 1996, p. 56). And, "The challenge of professional development… is to create optimal collaborative learning situations in which the best sources of expertise are linked with the experiences and current needs of the teachers" (NRC, 1996, p. 58).

A New Wave of Reform

The release of the *National Science Education Standards* (NRC, 1996) officially ushered in a new age of science education reform. A national call directed toward taking action was shouted throughout the land. This call was one that affected all disciplines of the natural sciences including physics. This call for reform of science education in the United States has been noted by researchers in the greater science community, including that segment of the community known as physics. The broad response of the physics community cuts across many levels of physics instruction. At the graduate level, change includes new subfields that cross disciplinary boundaries (e.g., materials physics, computational physics, biophysics, chemical physics, and photonics). Introductory college physics has also experienced much change in its content and instruction (Laws, 1991; Wilson, 1994).

The job market for physicists and other scientifically trained workers emphasizes the need for broader training within science, enhanced communication skills, and the ability to work in teams. Today's undergraduate students are more diverse than were students twenty years ago. Today's undergraduate students bring backgrounds and motivations substantially different from those of most current physics faculty when they were undergraduates. The term "Generation X" is a label for many of these students. It was contrived by the media and it carries all the germs of propaganda and stereotype (Brinkley, 1994). However, for discussion purposes, the term "Generation X" is useful in that it serves as a descriptor of a generation that has emerged from a radically changed, postmodern society and that is being educated by people from a previous generation who were reared under the tenets of the modern age (Sachs 1996). Generation X workers resent the labels that have been used to describe them: slackers, arrogant, disloyal, having short attention spans. In fact, these descriptions are less likely to reflect the behaviors of individuals in Generation X than the perceptions of managers who are not attuned to new ways of learning. The learning characteristics of the young adults classified as Generation X reflect the need for the new teaching and learning strategies promoted by cognitive scientists, such as learning in context, cooperative learning, and real-world application of knowledge. Having grown up with both parents working/furthering their education, Generation Xers are used to getting things done on their own. Hence, they tend to be independent problem solvers and self-starters. They want support and feedback, but they don't want to be controlled. Effective instruction requires the teacher to step outside the realm of their personal experiences into the world of the learner. It is the learner who must be engaged for learning to occur, the learner who must make the commitment to learn. F.M. Newmann, H.M. Marks, and A. Gamorman, (1995) point out that for learning to be meaningful (authentic), it must be individually constructed:

> “Learning takes place as students process, interpret, and negotiate the meaning of new information. This is heavily influenced by the students’ prior knowledge, and by the values, expectations, rewards and sanctions that shape the learning environment (p. 2).”

Authentic learning requires the learner to communicate an in-depth understanding of a problem or issue rather than memorize sets of isolated facts, and it must result in achievements that have relevance beyond school. Caudron (1997 p.4) offers the following suggestions for targeting instruction to individuals with learning characteristics such as those identified with Generation X:

- In classroom instruction and curriculum design teaching should focus on outcomes rather than techniques.
- Teaching Generation X students should also make student learning experiential.
- Instructors should give students control over their own learning as well as respect the learner’s ability to engage in parallel thinking.

- An instructor should attempt to highlight key points of the information when delivering information.
- Student motivation is key to their learning. As an instructor, one needs to provide new and exciting learning challenges to this generation of students.

Physics Education Research: A Documented Gap

Physics education researchers have documented a significant gap between what physics faculty members believe they are teaching and what students actually learn (McDermott, 1990). According to McDermott, many, if not most students in introductory courses, develop weak qualitative understanding of physics concepts, even when they may be able to solve successfully certain types of quantitative problems. Lacking exact quantitative solutions, students often have difficulty determining qualitative features such as comparison of magnitudes, determination of direction, and evaluation of trends (McDermott, 1997).

More broadly, students frequently lack a functional understanding of physics concepts, which allows problem solving in a context different from the one in which the concept was originally learned. Students find it difficult to transfer their ability to solve standard textbook problems to situations involving actual, real-world physical objects and phenomena (McDermott, 1997). Moreover, students exhibit a strong tendency to view phenomena and concepts as distinct, unrelated, and highly dependent on context rather than as comprehensible and derivable from just a few underlying universal principles (Reif, 1995).

Physics education researchers have also identified a number of factors that influence these learning difficulties. For example, students enter introductory classes with their own ideas about the physical world that may strongly conflict with physicists' views (Arons, 1997). Often called misconceptions or alternative conceptions, these ideas are widely prevalent and some are almost universally held by beginning students. Often well-defined, a misconception is not merely a lack of understanding, but a very specific idea about what should be, but in fact is not the case. Innovative pedagogical methods such as active learning are being developed to rectify these problems. However, in recent studies the reform efforts of the Physics Education Research community have yet to show a broad impact on the teaching of physics outside the Physics Education Research culture (Henderson & Dancy, 2008). In active learning, students engage in deeply thought-provoking activities requiring intense mental effort (Hake, 1998; Mazur, 1997). Van Heuvelen (1991) pioneered the process known as the Overview Case Study Method in which a cyclic approach to teaching concepts with multiple representations is followed up with a more complex "overview problem" as an assessment and learning activity for students. Van Heuvelen's students are frequently required to provide written or oral explanations of their reasoning process. This type of instruction recognizes and deliberately elicits students' preexisting alternative conceptions, which are then made a focus of discussion. As much as possible, scientific exploration and discovery are used as a means for learning science. Instructors avoid telling students that certain things are true, and instead guide students to "figure it out for themselves" either in the instructional lab, or by step-by-step theoretical analysis. Numerous attempts to disseminate these materials have been seen in the past. This can be witnessed by the overwhelming count of workshops, institutes, and conferences that have been advertized and conducted. These attempts have been undertaken by curriculum designers, innovation leaders, and the general populous of physics teachers who feel these teaching techniques and strategies are good, but research on the levels of their success are still being determined.

Background of the Study

Dr. Robert Beck Clark, former professor of physics at Texas A & M University and Thomas L. O'kuma, lead physics instructor at Lee College, developed a vision and then turned their idea into a 15-year project known as The Physics Enhancement Project for Two-year College Physics Instructors (PEPTYC). Like an infant who is born, grows up and eventually leaves her parent's house, so too has PEPTYC passed on to the final stages of its life after nearly 15 years of existence. Originally called the *Texas Two Year College Physics Enhancement Program*, the project was funded by the National Science Foundation (Clark & O'kuma, 1990) on January 15, 1991. Its inaugural funding cycle concluded on December 31, 1993 when its $221,690 funding ended. Clark and O'kuma received five subsequent grants totaling $1,724,160 from the NSF. These grants served over a hundred participants within the original Texas region and eventually across the continental United States, Hawaii, and Puerto Rico. The project is finally being retired as a model of professional development and a model for physics education reform curriculum dissemination. As noted previously, the question of long term success is still under review. The two-year college physics teachers who participated in this program were exposed to growth and change within the physics education reform movement through the final decade of the 20th century and are now moving into leadership positions at the two year college level.

Dr. William Kelly, retired Iowa State University professor of physics and former President of the American Association of Physics Teachers, stated in a personal conversation (Kelly, 2003) with Thomas O'kuma, Lee College and this researcher, that retired Texas A&M Dean, Dr. Robert Beck Clark, with the help of Tom O'kuma, had probably done more for the two-year college teaching fraternity than any other university professor in the country. He suggested that the professional development programs for two-year college physics instructors created by O'kuma and Clark started pivotal conversations between faculty members at four year universities and two-year colleges within the greater physics teaching community. These programs led to a stronger awareness among the American Association of Physics Teachers (AAPT) and to a greater role for scholarly activities within the two-year college physics-teaching community. Kelly's statements were made as an active member of and based upon his continued activities in the AAPT.

The PEPTYC Project

This project was designed to provide two-year college physics faculty members across the United States with a unique blend of contemporary physics knowledge, hands-on experience, innovative methods and techniques of physics instruction, and techniques for establishing "at-home" involvement with their communities. The PEPTYC program had four primary objectives. First, enrich, update, or establish instructors' background in modern physics areas such as particle physics, atomic physics, condensed matter physics, quantum optics, and physics education research. Second, improve instructors' basic skills in pedagogical strategies in all aspects of physics teaching, such as computer usage, effective demonstrations without professional support, innovative laboratory experiments, and improved multi-media techniques. Third, enhance or develop the involvement of two-year college physics instructors in their communities through programs such as workshops for colleagues, curriculum enrichment, public presentations, partnerships with industry and/or universities, and physics fairs and tests. Fourth, participate in organized discussions, also known as "cracker barrel" sessions, on program topics of critical interest to two year college physics teachers, such as training the technology workforce, articulation agreements with universities, remediation, curricula, textbooks, laboratory manuals, and professional development.

Description of the Study and Its Significance

The significance of this study is perhaps best understood in terms of the dearth of such studies found in the literature. Researchers know far too little about what happens as physics programs change and curricular innovations are implemented in undergraduate classrooms. Cannon and Crowther (1997) assert:

> "It appears from the literature that once a new program is developed, little has been done to investigate the implementation of the program. While some studies have investigated implementation procedures (Kyle, Bonnstetter, Sedotti, & Dvarskas, 1989; McMahon, 1990, p.3) little research has been offered into the knowledge base as of late."

This researcher investigated PEPTYC in terms of its effectiveness as a model for professional development practices as well as its effectiveness as a model for the dissemination of science curriculum, curriculum adoption, and the process of implementation of these curriculum changes. He also examined the effectiveness of integration of these new materials and ideas into the two year college physics teaching environment as an outcome from the PEPTYC project.

Research Questions

This researcher used a case study method of inquiry to produce a rich picture of an ongoing professional development process. He examined PEPTYC's creators and their perspectives, and the participants and their perspectives, both historically and via the effects of the program on their teaching and their integration of curricular changes in their institutions. Within this description, the researcher constructed answers to two questions:

1. In what ways did PEPTYC affect or change the teachers who participated in the program?
2. What were the effective and ineffective practices of PEPTYC that led to these changes in the teachers who participated in the program?

This analysis was done both holistically and specifically on selected participants from the project and included an analysis of the effects on their current physics teaching practices. The investigation ascertained what the participants deemed as effective practices and ineffective practices that arose from the program. During the final stage in the research, the program's philosophies, leadership, and participants were defined generally as the PEPTYC Professional Development Model. The discussions and ideas that follow came from the foundations and research on this professional development process originating as PEPTYC. The sources of data for this study ultimately included the following:

(1)Pre-existing data, which included, internal evaluation instruments as created by the PEPTYC Project coordinators and external evaluation instruments created by grant evaluators, project outcomes and reports; (2) Results from an e-mail survey which was distributed to all participants in every PEPYTC program who were still living or working as teaching professionals; and finally (3), a set of 14 in-depth interviews with selected participants from each of the various seven cycles of the PEPTYC program.

Research Objectives

A clear picture of the process behind creating the PEPTYC program was painted. The researcher looked at techniques the program directors applied to assist in the dissemination of Physics Education Research based curriculum to its participants. The researcher tried to understand the current paradigm in which curriculum dissemination occurs. According to Kuhn, a "paradigm" is a universally recognized scientific achievement that for a time provides model problems and solutions to a community of practitioners (Kuhn, 1962 p. 143). By examining who the participants were and where they had gone since being in the program, the researcher answered the question, "What affects did PEPTYC have on the present state of physics education in the Two Year College Physics Teachers Paradigm?" Kuhn claims, that science "development by accumulation" is difficult to defend, rather scientific development isn't a process of accretion, rather it is revolutionary (Kuhn, 1970 p. 69). Observations and descriptions of what many of the participants are currently doing after the PEPTYC program, has shown the researcher that a number of leadership positions have developed as well as new programs or recruitment efforts have been formed. Although not specifically reported in this project, many of these measurement benchmarks for success were monitored as part of this research. Ultimately, the researcher developed a rich description that allows readers to determine if and why the PEPTYC is a model professional development methodology for the dissemination of curriculum materials.

Delimitations

Describing the intellectual and methodological ground of a study is known as delimiting the study. Ten such delimitations were identified:

1. This study was conducted within a specific time frame and was bounded by the administration, staff and participants of the 15-year project PEPTYC.
2. The researcher examined a purposefully chosen subset of a group of participants.
3. The study is a naturalistic, qualitative study, where the majority of the data analysis can be characterized as ex post facto.
4. Data was gathered via face-to-face, telephone interviews, or e-mail.
5. The investigator was a direct participant in the program (PEPTYC IV) during its fourth two-year cycle, and he has served as an instructor/facilitator during phases six and seven of the ongoing project.
6. Subjects in this study are two year college physics instructors who agreed to participate in the professional development program knowing that they might be influenced to change the way they teach physics. Participants, as a part of the project, had also agreed to introduce modern physics content topics into their teaching.
7. The researcher purposefully selected only two interview participants from each of the seven PEPTYC institutes.
8. The researcher interviewed a subset of the general presenters, instructors, and facilitators, who participated in the instructional phases of the program.

9. The researcher had data that was previously collected by the project principle investigators, both internally and externally, available for his analysis. These included summaries of projects, presentations, and workshops given as part of the extended activities of the program.
10. Observations were made by the researcher during his participation as a student and an instructor of the program.

Limitations of the Study

Describing the intellectual and methodological ground of a study implies that ground exists beyond that staked out for the study. Describing such ground is called delineating the limitations of the study. Six such limitations were identified:

1. Employment of a case study methodology precludes generalization of the findings.
2. The researcher is the primary data gathering instrument; thus, the conduct and products of the research are dependent on his skills, habits of mind, and ability to avoid biases.
3. Effects on participants who have received other exposure to this curricular material are not part of the study.
4. A limited number of participants were interviewed.
5. The participants supplied self reported data only.
6. Data includes memories of participants from an event that occurred up to 15 years ago.

Definitions

Key terms that will be used throughout this study require definition. The following definitions have been researched through the literature, developed or adapted by the researcher for use with the study's context.

Qualitative research: Qualitative research encompasses a family of approaches, methods and techniques for understanding and thoroughly documenting attitudes and behavior. It crosses a variety of disciplines and perspectives in the social sciences as well as having application as a research approach in a wide range of practice areas. Generally speaking, qualitative research seeks the meanings and motivations behind behavior as well as a thorough account of behavioral facts and implications via a researcher's encounter with people's own actions, words and ideas (Mariampolski, 2001). This study uses open-ended participant interviews – a qualitative research strategy -- to examine the impact of the PEPTYC project.

Naturalistic Inquiry is a research philosophy proposed by Lincoln and Guba (1985) that challenges the assumption that all questions must be answered by employing empirical, testable, and replicable techniques. Rather than designing treatments and conducting experiments, naturalistic investigations are exploratory and inductive. They are embedded in the natural setting of interest and focus on observations within the setting, without altering the setting in any way. This study investigates the impact of PEPTYC program on its participants through open-ended interviews of participants after they have completed the program. Therefore, the study adheres to a naturalistic paradigm in that it does not alter the setting in any way.

Professional Teacher Development: "The process whereby prospective and practicing teachers participate in experiences that engage them in active learning that builds their knowledge, understanding, and ability while modeling good science teaching" (NRC, 1996, p.56). In this project, professional teacher development opportunities were provided through the PEPTYC Institutes.

Curriculum Dissemination and Diffusion: "The process of informing teachers about new or revised curriculum ideas, documents or materials, so that they *understand* and *accept* the innovation" (McBeath, 1991, p.23). The curriculum disseminated in the PEPTYC Project included a plethora of curriculum innovations based on physics education research, such as Interactive Lecture Demonstrations (Sokoloff, 2001), Workshop Physics (Laws, 1991), Peer Instruction (Mazur, 1997), and Visual Quantum Mechanics (Zollman, 1995-2000).

Curriculum Implementation: "The process of using a set of materials that includes both content and instructional guidelines, with a focused emphasis on *using*, not researching, designing, testing or revising curriculum." (Loucks-Horsley, Hewson, Love, & Stiles, 1998, p.62.). In addition to the aforementioned curricula disseminated by PEPTYC, the project also implemented lectures on modern physics topics that were created by research physicists at Texas A&M University.

Workshops, courses, institutes, and seminars: "Structured opportunities for educators to learn from facilitators or leaders with specialized expertise, as well as from peers. These usually occur outside the classroom and often bring together educators from different locations for common experiences. Courses and institutes provide opportunities for participants to focus intensely on topics of interest over relatively long periods (weeks in the case of institutes, months in the case of courses). Workshops and seminars tend to be offered for shorter periods and address more discrete learning goals." (Loucks-Horsley et al., 2003, p. 244).

May Institute: The PEPTYC project conducted a May Institute each year. Within this institute, the project conducted workshops to disseminate recent curriculum innovations. The participants attended seminars presented by active researchers in the field of modern physics and quantum optics. They also received graduate credit for course work completed during the two-year project cycle.

Case Study: "A case study is a detailed examination of one setting, or a single subject, a single depository of documents, or one particular event (Bogdan & Bilken, 1998; Merriam, 1988; Stake, 1995; Yin, 1994, p.54). The PEPTYC project is the specific case that the researcher investigated in this study.

Summary

In this chapter the researcher briefly introduced the broad scope of science education reform and the subsequent need for change in the way that physics education occurs. The researcher's central purpose in this study was to explore the implementation of PEPTYC, a program of professional development for two year college physics instructors. The research questions were set forth and key terms were defined. A review of research related to the implementation of professional development programs in the areas of science education, in general, and physics education in particular, is presented in Chapter 2.

CHAPTER 2: REVIEW OF THE LITERATURE

Introduction

In naturalistic inquiry (Lincoln & Guba, 1985) there are two general approaches commonly used to review the relevant literature. Some authors (Glasser, 1978) suggest performing a minimal review of the literature before entering the research field and conducting the review during and/or after completing the research. This approach allows more freedom to gather and respond to data, but it also predicates replication of previous work. Other authors (Merriam, 1988) believe that a thorough literature review prior to conducting one's research helps to focus a study with more established boundaries, allowing them make use of prior related work. To provide a framework for this study, the researcher conducted an extensive review of literature related to several relevant topics. These topics included a review of the evolution of professional development in education, the critical components of professional development for teacher education and its theories. The researcher reviewed prior research related to professional development as well as provided a summary of this literature review.

A Narrative Outline of the Literature Review

In this brief overview narrative the researcher has established the following progression through the literature research section. Focusing broadly, the initial section of the literature review places the context for the study as the setting of the community college system in general. A historical need for faculty development arises as the growth of the community college system in the 1960's and 1970's becomes evident. Demographic information from studies of the community college system is summarized and included (Monroe, O'kuma, & Hein, 2005). Specifically, one of the important needs for faculty includes the need for professional development. The *National Science Education Standards* revisited this need during the late 20th century (NRC, 1996). The characteristics of good professional development as discussed by authorities in the literature are presented. This includes a specific focus on the area of professional development known as workshops, institutes, courses and seminars. Promoting change in both individual teachers and within a teaching community was also addressed.

After an examination of the PEPTYC National Science Foundation grant proposals, a comparison of how PEPTYC aligned with the characteristics of good professional development also was presented. A great number of parallel characteristics to the characteristics of a good professional development model as described by Loucks-Horsley, Hewson, Love, and Stiles in their book *"Designing Professional Development for Teachers of Science and Mathematics"* are summarized here. These characteristics included experiences that were driven by a well-defined image of effective classroom learning and teaching as well as experiences providing opportunities for teachers to build their knowledge and skills. Additionally, the characteristics of these experiences included the use of modeling with teachers and the strategies the teachers will use with their own students. The development experiences of building a learning community with peers and the links to other organizations or support opportunities where teachers can take on leadership roles. Ultimately, effective professional development experiences continuously assess themselves and make improvements to ensure positive impact on teacher effectiveness, student learning, leadership and the teaching school community as a whole.

Establishing this groundwork lead the reviewer to examine how professional development is evaluated. The Kirkpatrick model framework for evaluation of training was the main framework analyzed (Kirkpatrick, 1959). Although designed as a corporate business model, its application to education training evaluation is accepted and debated (Guskey, 2000). The end goal of this research project was to examine change in behaviors and a teaching culture. According to Michael Fullan (2003), who was recently interviewed by Dennis Sparks for the Journal of Staff Development, "It has become increasingly clear from various sources that we need professional learning communities in which teachers and leaders work together and focus on student learning. But they must be infused with high-quality curriculum materials and assessment information about student learning." Fullan continued to discuss the work he had been doing in England with a four decade synopsis of teaching change. "In the 1970's, 'uninformed professional judgment' guided teaching. In the 1980's, 'uninformed prescriptions' provided through the accountability movement, were a driving force. In the 1990's, England had what it called 'informed prescription' because the prescription was based on sound knowledge and curriculum."

"Informed professional judgment" is now the goal in England. Researchers like Fullan (2003) are talking with English policy makers about the kinds of strategies that are necessary to go from the informed prescriptions that have helped them make progress in literacy and numeracy to informed professional judgment. According to Fullan, this would "actually change the cultures of schools." Fullan projects, "These policies would reduce the unnecessary workload of teachers, create more contact time among teachers to improve what they are doing, and develop more effective leadership at all levels."

The Kirkpatrick model describes the evaluation framework used to discover change resulting from transfer of behaviors learned from attending a professional development program by clients/participants of such programs. Finally, a criteria or checklist for evaluation was discussed by the researcher. Thus, the methodological process that will be undertaken by the researcher was discussed within the context of the study.

Community Colleges Instructors: Teaching or Scholarly Research

According to Outcalt (Outcalt, 2000), teaching is foremost the quintessential purpose for the existence of the community colleges. “Community college faculty stand out from many of their professorial colleagues not only because of the size and diversity of their sector of higher education, but also because teaching - far more than research or service - is the heart of their profession” (Huber, 1998, p. 12). The *Commission on the Future of Community Colleges* asserted the following in 1988, “The community college should be the nation's premier teaching institution. Quality instruction, should be the hallmark of the movement” (DeBard, 1995, p. 34). Cohen and Brawer recapitulate the point of community college commitment to teaching as follows, “First and last, the junior college purports to be a teaching institution. For the junior college instructor, then, the process of instruction is crucial to identity formation” (Cohen & Brawer, 1972, p. 13). Grubb (Grubb, 1999) maintains, as do some educational researchers, that community college teaching is given scant attention in the research writing. O'Banion agrees that “The unchallenged assumption was that the community college was the ‘teaching college,’ and the lack of research and publications on the part of its faculty was ironically cited as proof” (Huber, 1998, p. 12).

More recently, according to Monroe, O'kuma and Hein, (Monroe et al., 2005), some of the primary functions of the two-year college are: acting as a bridge between high school and further post-secondary studies, providing a return route for those who left the education pipeline, providing a means for vocational training and re-certification to future and current workers, and acting as a resource for adult education regardless of academic background.

Demographics of the Community College

Before considering the practice of teaching at a community college, a great deal more research and reflection appear to be necessary. It would be useful to outline a few demographic facts regarding community college faculty with regards to their teaching practice.

The American education system holds the two-year college in a unique place. The colleges began as post-secondary schools which were designed to serve specific regional populations. Two-year colleges developed, historically, into what became, and what we know today as junior colleges, technical colleges, and community colleges. Evolving as an intermediate level between secondary education and four-year university studies, a tremendous growth in two-year colleges occurred during the 1960's. According to Neuschatz and Blake's survey of physics instructors, as of 2000, 42% of students begin higher education for the first time at a two-year college (Neuschatz, Blake, Friesner, & McFarling, 1998).

Initially, two-year college instructors traced their roots to high school instruction. However, during the last quarter of the 21^{st} century, professional origins of community college faculty have shifted considerably. In 1973, about 54% of community college faculty had taught in high schools; this percentage had deceased to about 26% in 1993 (DeBard, 1995). The trend that DeBard's statistics show continues with far fewer two-year college teachers beginning their careers in high schools today. DeBard also notes many community college faculty hires now tend to come from graduate schools. It has remained a consistent employment source. Many of the instructors hired with experience as graduate teaching assistants at four-year colleges, however, do not make community college instruction their chosen career path. The significance of community college faculty for higher education cannot be overestimated: As Huber (Huber, 1998) reports, community college faculty constitute 31% of all United States higher education faculty, teaching 39% of all higher education students and 46% of all first-year students. Another interesting employment consideration is the "double dip" of recently retired instructors from various educational settings who are continuing to seek employment at another institution like a two-year college rather than actually retiring. The literature research done doesn't contain any definitive figures on these more recent occurrences. Cohen and Brawer (1996) note that a rising number of community college faculty members are minorities (14.5% in 1992) and women (44% in 1992). The proportion of two-year college faculty who has earned a doctorate has increased greatly throughout the 20th century. According to a 1987 study cited by Cohen and Brawer (1996), there are up to 22% of these faculty holding a doctorate degree. According to the American Institute of Physics (AIP) report on *Physics in the Two-Year Colleges*, the differences between full- and part-time physics faculty in these demographic characteristics were insignificant. The differences in academic background between full and part-time community college faculty were also insignificant. Among both full and part-time physics faculty, a little over one-third held a PhD. Almost all the rest held a master's degree. In both groups, roughly two-thirds had earned a graduate degree in physics.

The average age for professionals teaching in the community college system has increased steadily since the initial flourish of hiring in the 1960's. It appears that this figure will likely decrease substantially when these current instructors retire and begin being replaced by younger colleagues (Cohen & Brawer, 1996). Furthermore, citing the American Institute of Physics (AIP) report on *Physics in the Two-Year Colleges,* 89% of physics faculty in community colleges was male. The report also shows the median age of physics faculty in the community college system to be 49 years. The demographics included 89% white, 6% U.S. minorities and 5% who were non-U.S. citizens (Neuschatz et al., 1998, p. 21).

Obstacles to Effective Teaching in the Community College

When talking to community college instructors, as well as reviewing the educational literature, a pattern of a somewhat dispiriting assortment of obstacles to good teaching in community colleges emerges. According to the American Institute of Physics (AIP) report on *Physics in the Two-Year Colleges*, the major problems cited by full-time faculty as impediments included students' weak mathematics background (53%), insufficient funds for equipment and supplies (47%), and inadequate space for labs or outmoded facilities (34%) (Neuschatz et al., 1998, p. 34).

Further literature research as well as anecdotal evidence from the TYC 21 project headed by Monroe (Palmer, 2000) supported the data discussed in the AIP report above and highlighted these additional obstacles. Obstacles which include faculty isolation, a growing reliance on part-time faculty who are accorded substantial teaching loads without concomitant institutional support, increasing pressure for community college faculty to undertake research, under-prepared students, and inadequate resources for faculty development. These are not exclusive obstacles across the two-year college continuum. As noted previously, physics instructors attempted to study their effects through an American Association of Physics Teachers Project called Two Year Colleges in the 21st Century (TYC 21). The National Science Foundation funded TYC 21 project was developed by Mary Beth Monroe, Marvin Nelson, and a group of interested community college collaborators (Palmer, 2000) who organized their network of physics teachers before the end of the millennium. Numerous white papers, conference proceedings, and project reports were published discussing these obstacles for community college physics teachers in general (Palmer, 2000).

Isolation of Teachers:

The first obstacle for community college teaching is faculty isolation. In his qualitative analysis of community college instruction, Grubb (1999) and his associates interviewed and observed 60 community college administrators and 257 instructors. Grubb established that faculty isolation is a key barrier to effective teaching: "Except in a small number of exemplary institutions, most instructors speak of their lives and work as individual, isolated, lonely. A teacher's job is a series of classes, with the door metaphorically if not physically closed" (Grubb, 1999, p. 49). One lecturer described the situation as follows: "From the day I entered this place to right now, you sort of figure out how you're gonna teach yourself" (Grubb, 1999, p. 49). Grubb found that faculty teamwork tends to lead to successful instruction; however this collaboration is oftentimes complicated with community college instructors and the problems they face with varying degrees of isolation (Palmer, 2000).

The American Institute of Physics (AIP) report on *Physics in the Two-Year Colleges* also asserts that the relative isolation of two-year college faculty is a major area of concern (Neuschatz et al., 1998, p. 26). The report mentions that nearly half of all community colleges have only one physics faculty member. Additionally, faculty who are geographically isolated have few opportunities for professional development. The AIP survey also found that an unusually high percentage of full-time faculty spend their entire careers teaching at the same two-year college, leading to greater isolation and lack of exposure to new approaches.

<u>Part Time Instructors:</u>

The growing dependence on part-time community college faculty is outside the scope of this research. For a more thorough synopsis of this problem, see Gappa & Leslie (1993). In addition, an extended discussion of part-timers in higher education can be found in Banachowski (1996). Nevertheless, a brief outline of this research would be useful to contextualize the relationship between part-timers and teaching. It appears that a growing proportion of community college instructors are considered part-time faculty. Part-time faculty formed approximately one-third of the total community college teaching force in the 1960's; this figure grew to 60% in 1986, but then declined to 53% in 1992 (Cohen & Brawer, 1996). This proportion of part-timers might provide a misleading notion of the actual percentage of courses taught by part-time instructors because part-timers usually teach fewer courses than do full-timers.

According to the American Institute of Physics (AIP) report on *Physics in the Two-Year Colleges*, full-timers were compensated at an income level of $42,000 for nine-month appointments (Neuschatz et al., 1998, p. 25), while part-timers were typically paid about $2,000 per course or about $500 per credit hour (Neuschatz et al., 1998, p. 38). Part-timers also received a far lower level of institutional support in the form of office space, supplies and professional development opportunities (Neuschatz et al., 1998, p. 25). As a result of these disparities, part-timers typically felt underappreciated, (Neuschatz et al., 1998, p. 42) compared to full-timers.

Gappa and Leslie (1993) contend part-timers do not participate in the "full operation" of the two-year college institutions, at least not in as many ways as full-timers do. Part-time instructors tend to contribute only in classroom activities because they are compensated only for their classroom time and instruction. Hence, administrative and institutional duties are delegated to full-timers rather than their part-time colleagues. Part-timers are not accorded the institutional support offered to full-timers, such as participation in professional development activities that might strengthen their teaching. Grubb's research also yields another viewpoint, "The most immediate effect of using so many part-time teachers is to undermine their own careers" (Grubb, 1999, p. 332). In other words, the practice of teaching part-time has become, for some instructors, a full-time profession with few of the benefits or pay of full-time employment. Digranes and Digranes (1995) discovered that part-timers tend not to integrate innovative teaching techniques into their instructional repertoire, possibly as a result of their own relative isolation from other full-time faculty members. Rifkin (1998) explored the tensions between part-timers and full-timers, as well as the complex nature of part-timers' instructional practices. In her research involving 1,554 faculty at 127 community colleges nationally, she found that in spite of showing lower levels of institutional attachment and scholarship, part-timers articulated higher expectations for their students.

<u>Research and Scholarly Activity:</u>

Michael Neuschatz, in his American Institute of Physics (AIP) report on *Physics in the Two-Year Colleges*, (Neuschatz et al., 1998, p. 27) provides the research data which shows most two-year college faculty limited their research and scholarly activities to attendance at professional meetings. Heavy teaching responsibilities in two-year colleges were often considered to be barriers to more participation in research and scholarly activities that could lead to enhancing the knowledge base in physics or in the field of physics education.

Although not usually a requirement, an increasing pressure on community college faculty to engage in research was also noted by several authors. Huber (1998) found that about 26% of community college faculty engaged in research regularly, with a similar number asserting that research was necessary for effective instruction (half the proportion of all higher education faculty who stated this). Pressure to engage in research might be related to a strong tendency for some community college faculty to emulate their four-year counterparts, including the extent of faculty training. Cohen and Brawer (1984) reported that the period of preparation for entry into the profession was growing longer, particularly because increasing numbers of faculty possess the doctorate. Nevertheless, as Lawrence (1989) found, the possession of a doctorate may have at most an indirect relationship to teaching practice, and so its acquisition is at best an indirect form of preparation for the instructional mission of community college faculty.

The American Institute of Physics (AIP) report on *Physics in the Two-Year Colleges*, (Neuschatz et al., 1998, p. 36) appears to support the assertion above. Among the full-time faculty with master's degrees surveyed, 36% made the choice to teach at a community college while attending college, while 16% made the decision only when they were further along in the job search process and other options appeared to be unavailable. Conversely, among the full-time faculty with doctorates who were surveyed, 20% made the choice to teach at a community college while in college, while 34% made the decision only when they were further along in the job search process and other options appeared to be unavailable. Thus, for physicists with a master's degree, the choice to teach at a community college appeared to be more pre-planned than forced. Conversely, for physicists with a doctorate, the choice to teach at a community college appeared to be more forced than pre-planned.

Grubb's assertion that research and teaching are antithetical might be disputed by those who argue for an increased research and publishing role for community college faculty. In his investigation into administrators' attitudes toward faculty research, Marshood (1995) relied on the distinction between research (activity intended to lead to a scholarly publication) and scholarship (concentrated study of a particular topic), which might be useful in resolving the tension between those who support increased research and scholarship for community college faculty. Questions of non-teaching professional activity on the part of community college faculty, principally related to research and scholarship, summon even greater dilemmas related to the institutional mission of community colleges. These dilemmas are not likely to be solved by neat dichotomies.

Under-Prepared Students:

A fourth obstacle to teaching at a community college is under-prepared students. The American Institute of Physics (AIP) report on *Physics in the Two-Year Colleges* reports on extensive complaints about incoming students without sufficient skills to handle the complexity of higher education. Over 90% of the respondents described the weak mathematics background of their students as a severe problem. The report also asserts that the coordination of support services and teaching resources on campus to help these students is an area of concern for community college faculty.

Huber (1998) notes that the open-door environment of most community colleges often leads to an instructional challenge in the form of under prepared students. As she notes, "While faculty at all types of colleges and universities say that their students could be better prepared for college work, under preparation is most marked at community colleges, most of which are open to any who wish to enroll" (Huber, 1998, p. 19). Huber also affirms that the large majority (over 70%) of community college faculty accept as truth that a sizeable amount of institutional resources are devoted to developmental education.

At the researcher's own institution, Cloud County Community College, about 70% of the incoming freshmen class show a need for developmental education in either English or Mathematics. According to Cloud County Community College's graduate exit survey, these students are attracted to the college because of its small class sizes and individualized instruction. The American Institute of Physics (AIP) report on *Physics in the Two-Year Colleges*, also asserts that "small class size may be especially helpful for students who enter college at risk for failure. Without a strong academic background, such students may often find themselves lost in the anonymous world of large lecture classes. Greater contact and interaction with faculty often help these students over the initial barriers and maximize their chances of success. One mission of the community college is to act as a "bridge" between secondary and post-secondary education. However, the smaller scale can potentially "benefit all students, not just those at risk." Thus, community college faculty are often faced with the task of teaching under-prepared students who have been attracted to a community college mainly because it affords the advantage of small class sizes.

Inadequate Resources:

One of the other more concerning problems is inadequate resources for professional development. Unfortunately, many professional development programs seem ill-designed to assist community college faculty in improving their teaching. In general, studies on the topic have determined that professional development activities are nominally available to community college faculty (although not all options are offered to part-time instructors), but faculty face barriers in gaining access to them. Berman and Weiler (1987) report on the status and effectiveness of faculty development programs in California's system of higher education. They found that these programs were impaired by poor planning, limited access, and insufficient size, and that these programs did not have a significant impact on teaching. A study by the Illinois Community College Board (1988) of community college faculty professional development programs in Illinois found that these programs were available on a formal basis in approximately two-thirds of the responding districts, and informally in nearly all districts. Many of the most resource-intensive types of activities, such as conference travel and sabbaticals, were available only to full-time instructors. A study of faculty attitudes toward professional development by Seppanen (Seppanen, 1990) within Washington State's community colleges found that the single most desired type of activity was training in working with and understanding the needs of students. This study also found that faculty reported insufficient time to take advantage of such activities. More recently, Murray (Murray, 1999) used a random national sample to survey more than 100 community college chief academic officers regarding their campus professional development programs. He found "a glaring lack of commitment on the part of the leadership for faculty development" (Murray, 1999, p. 58). Further, Murray noted that professional development programs continue to be hampered by several other factors, including insufficient organization, a lack of transferability between institutions, and the use of a mix-and-match approach rather than a comprehensive, effective strategy. Grubb's findings regarding the inadequacy of professional development programs echo those of other researchers. Even when these programs are available, they tend to be, in Grubb's words, "formulaic, contrived, and often not focused on teaching" (Grubb, 1999, p. 285). Grubb found that instructors desired professional development activities that were integrated into their professional lives rather than mere one-session affairs. Furthermore, they wanted activities that held at least an implicit focus on building and sustaining collegiality between themselves and their peers.

How do community college professionals overcome obstacles? Fortunately for community college faculty and their students, the education literature is replete with examples of successful developments in the realm of instruction. Many of these successful strategies call on instructors to learn to work more closely with one another, and to devolve at least some instructional authority to one another (often via team-teaching approaches) and to their students. As Huber states, “Indeed, at many campuses, a climate of innovation in teaching is already well underway. As one community college professor wrote, “This is a very exciting time at my college. Collaborative learning and teaching is the focus, and it is changing my views about the education process" (Huber, 1998, p. 13). Grubb's findings echo Huber's: “We were struck by our finding that the most innovative practices seem to emerge from collective efforts, not from individual instructors” (Grubb, 1999, p. 199).

Professional Development History

Professional development in the community college began as a movement in the early 1970’s. It developed without a specific event prompting its start and evolved out of the rapid growth that community colleges were experiencing at the time. The researcher’s purpose of this section of the literature review is to provide the reader with a perspective on why faculty development is needed, discuss some of the early difficulties for professional developers and provide a description of the professional development field in the two-year college setting at its present status, including challenges for the future. Despite the growth of community colleges in our society and the claim that the strength of these colleges lies in their faculty, very little research has been done in recent years to provide insight into this group of academic professionals.

Researchers have looked cyclically at faculty job satisfaction, preparation, staff development, issues of teaching and learning, and career stages. (Barnsley, 1992; Carter & Ottinger, 1992; Cohen, 1972; Frankel, 1973; Keim, 1989; O'Banion, 1972). Yet, these findings are often drawn from the extremes of national survey data or discipline-specific studies (DeBard, 1995; Zappia, 1995). Additionally, portrayals of community college faculty are often derived from subsets of larger studies of postsecondary faculty or from using four-year college models to study two-year college faculty (Blackburn & Lawrence, 1995; Furniss, 1981). Few studies have focused on developing two-year college faculty models or on beliefs about and constructions of the community college faculty role.

A Need for Professional Development

According to O'Banion, (1972) professional development in the two-year college setting began to grow in response to the realization that the rapid growth of new community colleges in the 1960's and early 1970's was waning and that people, rather than buildings, programs, and organizational structures, needed attention. More specifically, a number of factors precipitated the need. Among those that Hammons, Wallace, and Watts (1978) identified were: the need for increased effectiveness and efficiency due to competition for limited tax dollars and beginning public demands for accountability; the acknowledgment that the future success of the community college depended on the ability of its personnel to adapt to a constantly changing environment; the development of technology for instruction with potential for improved instruction was unknown to most faculty; an awareness among faculty that they were becoming unable to cope with the needs of the increasing percentages of "high-risk" students enrolling in community colleges; a recognition among leaders that change was imperative and that they needed to become skilled in planning, implementing, and evaluating change; the increasing influence of court decisions, collective bargaining, and federal regulations on institutional governance; and the occurrence of a relatively high turnover in leadership positions at the mid-management levels.

These needs have been surprisingly consistent over the last few decades. In the most recent writing on faculty and staff development, Bellanca (2002, p. 35) states that "More than at any other time in their history, community colleges need to plan and provide comprehensive ongoing professional development programs for their faculty and staff. Faced with an increasingly diverse student body with varying expectations, learning styles, and service preferences; new and growing competition; technological advancements; and changing governmental policies and societal demands, community colleges can no longer respond in traditional ways." Compounding this list of needs, community colleges are facing faculty and leadership shortages. Not only will those newly hired into a community college over the next decade need to be well trained to meet the challenges mentioned above, but they will also need to be acclimated to the community college itself. The question may not be whether community colleges need staff development, but rather, can they do without it.

In the 1970's and 1980's faculty struggled primarily with two closely related issues: legitimacy and identity. The former arose from the struggle to become a "program" instead of a loose collection of activities that may or may not happen on a regular basis. For professional development to achieve program status, someone had to champion the cause, a senior level administrator had to make a commitment to professional development, some funds had to be allocated, and someone had to be assigned responsibility for the program. If all this came to pass, then some sense of legitimacy existed. However, the struggle then became one of identity, and the question became: "How does a professional development program become an entity that can actually make a difference in the college?" That question gave rise to a whole host of more specific questions regarding how the program should be organized, how needs should be assessed, what types of activities can meet those needs, and how the program should be evaluated.

The answers frequently resulted from trial and error, but the questions also spawned a concerted effort to discover and share answers. During the 1970's and early 1980s, the National Council for Staff, Program, and Organizational Development was formed, as was the National Institute for Staff and Organizational Development. At least three monographs directly related to organizing and developing community college faculty and staff development programs were published in its first issue of *The Journal of Staff, Program*, *and Organizational Development*. National conferences were established, and Title III monies to implement staff development programs flowed freely to institutions that qualified. As a result, programs flourished, and staff development at community colleges gained an identity. However, for many programs, success was short lived. By the mid 1980's, the United States experienced an economic downturn, and community colleges found themselves financially strapped. In those financially troubled times, administrative leadership thought that faculty and staff development was expendable, and in fact, many programs fell to budget cuts. The loss of programs was compounded by the fact that when Title III funds expired, most institutions no longer had the financial means to continue programs that had been supported by those funds.

Formula for Change

The formula for change was created by Richard Beckhard and David Gleicher and is sometimes called *Gleicher's Formula*. (1987) This formula provides a model to assess the relative strengths affecting the likely success or otherwise of organizational change programs. Later in this literature review the researcher discusses the formula which contains a component referred to as resistance to change. With the changing attitudes of funding, organizational changes related to professional development were often times destined to fail.

Identity, but not Institutionalization

Faculty and staff development had certainly gained some identity but, in too many cases, did not possess enough legitimacy to survive. During that period, the term institutionalization came into fashion to describe both the plight and the ultimate goal of professional development. To be "institutionalized" meant that an institution's program had become such an integral part of the fabric of the institution that it would remain secure through whatever financial crisis might befall it. It was the ultimate form of both legitimacy and identity. Likewise, the existence of those programs that were not institutionalized was in jeopardy.

Present Status

According to Watts and Hammons, (2002) three decades into the movement, faculty and staff development programs are running the gamut from fledgling programs to programs that are comprehensive. What does the literature show as critical challenges for professional development in the community college setting? Richard W. Riley, Secretary of Education in 1993, addressed this question in his work, *The Emerging Role of Professional Development in Education Reform*. (Riley, 1993).

There are still community colleges in which professional development is viewed more as an "add on" than a necessity. To overcome that perception, community college presidents must understand and espouse the value and critical components of a comprehensive professional development program. Further, community colleges need to consider faculty development as part of the cost of doing business and too important a function to be left until last in budget allocation. One way to further institutionalize professional development is to make participation one of the criteria used in appraising performance. "The success of a community college is due to its ability to change to meet the needs of a changing clientele." (Watts & Hammons, 2002, p.5) In the past, much of this change occurred through the addition of personnel with the knowledge, skills, or attitudes needed to accomplish the changes. For the foreseeable future, community colleges will be faced with the same or even greater need to change but must do so with senior people (many of whom are approaching retirement) or newly hired, inexperienced people—which means that professional development is essential. G.E. Watts and J.O. Hammons in their article New Directions for Community Colleges, (2002) note that, "Professional development should no longer be considered a voluntary activity, and colleges will need to award credit toward promotion and tenure for participating in professional development activities and subsequently improving their performance." Watts and Hammons (2002) also conclude that, "As a programmatic challenge, professional development should be considered a means rather than an end." They felt that when taken as an end, there was too much emphasis placed solely on the number of programmatic activities generated during a year as well as just making a count of the number of people involved in those activities. If this is the philosophy that is followed, then the focus for those who lead professional development can too easily become planning, implementing, and attendance reporting. That in itself is not necessarily a detriment to a professional development program; planning, implementing, and reporting need to occur. In professional development the focus shifts beyond the program to the organizational level when professional development is seen more as a means rather than an end. "Instead of professional development justifying its existence with numbers, it can more appropriately focus on the linkage between programmatic activities and the accomplishment of organizational goals", Watts and Hammons (2002) claim. Having such a focus integrates professional development more fully into the institution and sets the stage for more meaningful evaluation of professional development.

Another programmatic challenge is to recognize that professional development should include personal development. Faculty development exists to improve performance. To improve a person's performance, there is a need to focus on the whole individual, not just that part that relates to the job.

Historically, faculty members have been the target of most development activities. There is abundant evidence to support the need for staff development for counselors, managers, board members, and classified staff. Singling out faculty, for example, often results in situations where faculty efforts at incorporating their newly learned skills are hampered by persons who were not included in the training (McKelvey & Cahper, 1984**).** In a substantial number of community colleges, the responsibility for coordinating professional development revolves among faculty or other staff members every two to three years. Therefore, those persons given the responsibility should be selected with care. The coordinator of professional development, whether full time or part time, is obviously a key person in the success of the program and should be selected with certain skills and attributes in mind. The skills and attributes that a coordinator must possess to be successful include: a master's degree; an unquestioned reputation as a good teacher;

good organizational abilities, especially goal setting and planning; the confidence and respect of the administration; realistic expectations about what can and what cannot be done given available resources and time; and an ability to get things done with existing resources. He or she should also have a non-threatening personality, an understanding of adult learning, and some training or expertise in human relations, group process, instructional design, organizational development, and strategies for implementing change. Although each of the foregoing challenges is important to the future success of professional development in community colleges, program evaluation was and remains the process that needs the most attention. Programs must be adequately evaluated to assess their effectiveness and to be accountable for the resources entrusted to them (Kutner & Tibbetts, 1997).

National Science Education Standards

The *National Science Education Standards*, (NRC, 1996), calls for teachers to focus on the "big ideas" in science, use inquiry-based strategies, employ an array of pedagogical approaches ranging from didactic teaching to extended explorations, guide and facilitate the learning of diverse student populations, teach for understanding, and focus on students' application of knowledge. The implications of this vision of standards-based instruction on the preparation of teachers are enormous. Training teachers to meet the challenges implicit in this vision of standards-based instruction indicates that teacher-preparation policies and programs need to improve the content knowledge and pedagogical strategies of teachers; improve their understanding of the diverse ways that students learn and understand; and enhance their abilities to frame questions, choose activities, and assess student learning appropriately. For teachers who are currently working at a two-year college setting, this type of new instructional basis needs to be delivered to them via a well-planned and process-oriented professional development experience.

National Standards for Professional Development for Teachers of Science

According to the National Standards for Professional Development, (NRC, 1996) professional development for teachers of science requires learning essential science content through the perspectives and methods of inquiry. Science learning experiences for teachers must involve teachers in actively investigating phenomena that can be studied scientifically, interpreting results, and making sense of findings consistent with currently accepted scientific understanding. Additionally, professional development for these teachers must address issues, events, problems, or topics significant in science and of interest to participants. Professional development should introduce teachers to scientific literature, media, and technological resources that expand their science knowledge and their ability to access further knowledge and build on the teacher's current science understanding, ability, and attitudes. Furthermore, it should incorporate ongoing reflection on the process and outcomes of understanding science through inquiry with an effort to encourage and support teachers in their efforts to collaborate.

The program standards found within the National Science Education Standards (NRC, 1996) include the following views about science education programs. The program of study in science for all students should be developmentally appropriate, interesting, and relevant to students' lives; science education programs that are developed to teach college professionals should emphasize student understanding through inquiry and be connected with other school subjects. The K-12 science program must give students access to appropriate and sufficient resources, including quality teachers, time, materials and equipment, adequate and safe space, and the community. The most important resource is professional teachers. Good science programs require access to the world beyond the classroom.

Further examination of the National Science Education Standards (NRC, 1996) show, that teachers of science should plan an inquiry-based science program for their students. Professional development opportunities that incorporate these practices are of paramount importance. In doing this, teachers need to select science content and adapt and design curricula to meet the interests, knowledge, understanding, abilities, and experiences of students. They also need to select teaching and assessment strategies that support the development of student understanding and nurture a community of science learners, all of which include working together as colleagues within and across disciplines and grade levels. Nurturing a community in an instructional setting where isolation is a norm produces a great challenge for the community college science instructor.

Additionally, teachers of science guide and facilitate learning. In doing this, teachers need to focus and support inquiries while interacting with their students. They also need to challenge students to accept and share responsibility for their own learning, while encouraging and modeling the skills of scientific inquiry, as well as the curiosity, openness to new ideas and data, and skepticism that characterize science. Teachers of science design and manage learning environments that provide students with the time, space, and resources needed for learning science. In doing this, science teachers structure their time that they are available, so that students are able to engage in extended investigations. They create a setting for student work that is flexible and supportive of science inquiry, ensure a safe working environment, and make the available science tools, materials, media, and technological resources accessible to students. A teacher who is following the standards also needs to identify and use resources outside the school and engage students in designing their learning environment. Finally, teachers of science need to develop communities of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to science learning. In doing this, teachers enable students to have a significant voice in decisions about the content and context of their work and require students to take responsibility for the learning of all members of the community. They also nurture collaboration among their students and model and emphasize the skills, attitudes, and values of scientific inquiry. It appears, however, that they can only succeed in this endeavor by experiencing highly professional, well-organized professional development.

In this literature review the researcher has examined the extent to which these *National Science Education Standards* (*NSES*) have influenced the system of professional development. He investigated the evidence that the *NSES* have influenced various components of the professional development system that shape, construct, and deliver professional development at the national, state, and local levels. The researcher characterized the differing quality of evidence that contributes toward any conclusion of the influence of the *NSES* on the system of professional development. Rather than examining the influence of the *NSES* on particular professional development programs or on the practices of individual teachers, he has taken a macro perspective for examining the influence of the *NSES* on the various aspects of the system of professional development. Hence, reporting is primarily based on the influence of the *National Science Education Standards*. Overall, the researcher found that the influence of the *NSES* on the system of professional development appears uneven. On the one hand, there seems to be substantial evidence that they have influenced a broad swath of in-service professional development programs. Most of the evidence points toward the influence of the National Science Foundation and Title II of the old Elementary and Secondary Education Act, the Eisenhower program. On the other hand, there is less evidence that the *NSES* have successfully influenced the state and district policy structures that leverage more fundamental changes in such areas as professional development standards, teacher licensing, or re-certification requirements. Additionally, the evidence is thin that institutions of higher education are participating in this movement.

Three General Recommendations: Professional Teacher Programs

"College and university science, mathematics, and engineering departments should examine their introductory courses and 'assume greater responsibility' for providing prospective teachers with courses that have appropriate content and model appropriate pedagogical approaches" (NRC, 1996). This statement came from the National Resource Council Report addressing education of science and mathematics instructors. Although it is a recommendation focused toward undergraduate instruction, these programs are the foundations of the two-year college teaching workforce future. Today's instructors need opportunities to learn how to model these new pedagogical approaches.

The following three general recommendations from the NRC report (2000) about what should be included in a professional teacher program parallel the long term goals of any effective professional development program designed to assist the community college with training to apply appropriate pedagogical approaches to their classes.

1. "Teacher education in science, mathematics, and technology should be viewed as a continuum of programs and professional experiences that enables individuals to move seamlessly from college preparation for teaching to careers in teaching these subject areas."
2. "Teacher education should be viewed as a career-long process that allows teachers of science, mathematics, and technology to acquire and regularly update the content knowledge and pedagogical tools needed to teach in ways that enhance student learning and achievement in these subjects."
3. "Teacher education should be structured in ways that allow teachers to grow individually in their profession and to contribute to the further enhancement of both teaching and their disciplines" (NRC, 2000).

Universities performing educational research should place priority on research into "ways to improve teacher education, the art of teaching, and learning" (AIP, 2000), and the data should be made available through a national electronic database or library. Colleges and universities should provide continuing guidance to teachers who have completed their teacher education programs and should "assume primary responsibility for providing professional development opportunities" for science and math teachers (AIP, 2000) .

Components for Effective Professional Development

Kraft (1998) suggests that it is difficult to effect change in educators because many teachers continue to utilize outdated modes of professional development presented through single-day workshops or in-services. Implementing new practices and innovations in schools requires that teachers be allowed the opportunity of integrating new ideas for "improved practice into a coherent sense of how these fit into their own understandings and assumptions about good learning and teaching" (Caine & Caine, 1997, p.8). Kraft (1998) has formulated nine components of effective professional development for teachers that can be applied to teacher educators. Those nine components of professional development for teachers are:

Teacher Involvement.

Teachers are defined as conceptualizers of reform initiatives as opposed to implementers of others' conception. This ongoing, interactive process encourages teachers to discuss their perceptions during the change process and to solve problems as they arise.

Content in Context.

Professional development should emerge when problems confronted by educators are analyzed. Focusing professional development upon why problems occur assumes that there are several possible reasons for any challenge and that a range of possible solutions exists. Interrelationships can be theorized in this manner rather than focusing solely upon linear cause-effect chains.

Sense of Continuity.

Curriculum is the most logical connection to professional development. Professional development should not be separate from teaching and learning but should provide support to participants and a sense of continuity over time.

Sense of Collegiality.

A shared dialogue within a community of learners exemplifies collegiality. Little (1981) theorized that educators display collegiality by talking about teaching practice, working together on curriculum, teaching each other what they know, and observing each other engaged in the practice of teaching. Educators who display collegial behaviors during the professional development process, when compared to faculty not utilizing teaming or collaborative efforts, are better decision-makers, motivated, trusted by adults, energized adult learners, and efficient implementers of decisions (Barth, 1990).

Reflective Practice.

Reflection of professional practice refers to the capacity of teachers to critically, imaginatively, and creatively review classroom practice. Reflection requires that educators view themselves as learners and schools as learning environments.

Conceptual Approach.

Professional development processes should conceptually engage teachers and promote cognitive growth. Phillips and Glickman (1991) suggested that educators who utilize high conceptual levels are able to think of more ideas when planning, more effectively diagnose instructional problems, utilize a variety of teaching approaches, communicate with students on a high quality level, and project consequences of actions.

Team Building Emphasis.

Feelings of commitment and working together for the purpose of improving learning and teaching are necessary if educators are going to function effectively and productively as team members for the purpose of collaborative decision-making. Professional development should teach participants to problem solve, process information, play productively, communicate assertively, practice consensus decision-making, and resolve conflict.

Based on Principles of Adult Learning.

Professional development activities must acknowledge and build upon principles of adult learning. Learning styles should be considered. The learning climate should minimize anxiety and encourage freedom to experiment.

Include an Evaluation Component.

Evaluation is critical in convincing decision-makers to allocate funding for professional development. Professional development must reflect upon the impact that the last effort had upon learning and teaching."

A Theoretical Basis for PEPTYC

When this researcher asked what the theoretical basis for the PEPTYC Program was during a pre-research interview with Dr. Robert Beck Clark, Texas A&M University, co-principle investigator of the project, he said, "*Experiential learning* and *peer instruction*, not the model of "Peer Instruction" that Eric Mazur (1997), of Harvard University discusses but the model that was established during the PTRA (Physics Teacher as Resource Agents) programs I was a part of in my early career" (Clark, 2003). According to Clark, he didn't really do any consultation of the professional development literature and research. Clark just talked with his teaching colleagues and based the approach on anecdotal evidence that they said would be effective and work. Clark stated, "Fifteen years later it appears to have been right, or at least based upon our evaluation of the results of the program. It was an empirical approach, grounded in the reality of the context" (Clark, 2003). The aforementioned nine components of effective professional development, as advocated by Kraft, have one commonality, that of collaboration. The process of collaboration was a major component of the PEPTYC Professional Development model, according to Clark (2003). "We thought that the teachers teaching teachers model was an excellent process during the PTRA programs, and we went with it." (Clark, 2003) According to Lieberman and Miller, (1990) Collaboration promotes teaming with other educators for the expressed purpose of improving classroom practices. They also commented that the greatest irony, and perhaps the greatest tragedy of teaching, is that so much of the process occurs in self-imposed and professionally sanctioned isolation. As previously stated in this research, one of the major obstacles for the two-year college physics instructor is isolation (Palmer, 2000). The creation of professional development opportunities, like workshops or institutes that promote the process of collaboration, promotes collegiality among teachers, and ignores previous isolationist practices, are ideas that saturate throughout Kraft's nine basic components. Collaboration is a group process in which educator participants share a common goal and determine outcomes through shared discourse. Utilization of collaboration in each of Kraft's components for professional development allows educators to participate in a reflective process that ultimately transforms their teaching practice. Additional parallels of these nine components that are held within the PEPTYC program will be examined during the data gathering and research analysis phases of this project.

A Professional Development Toolkit

Fifteen strategies for professional development have been isolated as a general "toolkit" from which professional developers can design their programs or initiatives. These fifteen strategies have expanded the professional developer's repertoire beyond the typical in-service workshops, courses, and institutes normally provided for educators. Using these as a guide and selectively choosing the experiences will promote opportunities for teachers to grow professionally in areas of knowledge and skill in a variety of contexts. According to Loucks-Horsley and her co-editors (Eisenhower & Clearinghouse, 1998), there are fifteen strategies for creating effective professional development. These strategies include the following, which are categorized into five different types of activities designed to focus on creating teacher change. The five focuses on change are also designed to develop awareness, build knowledge, translate ideas into practice, practice the teaching process, and actively reflect upon of the ideas and information constructed from these strategies. The five main categories for professional development methods are labeled as Immersion, Curriculum, Examining Practice, Collaborative Work, and Vehicles and Mechanisms. Underlying each of these categories are the fifteen supporting strategies that have been categorized by the researcher under the five main change building categories as bulleted and included below:

Immersion (Develop Awareness)

1. Immersion into inquiry in science:
2. Immersion into the world of scientists:

Curriculum (Build Knowledge)

3. Curriculum implementation:
4. Curriculum replacement units:
5. Curriculum development and adaptation:

Examining Practice (Translate Ideas into Practice)

6. Action research:

7. Case discussions:
8. Examining student work and thinking, and scoring assessments:

Collaborative Work (Practice the Teaching Process)

9. Study groups:
10. Coaching and mentoring:
11. Partnerships with scientists in business, industry, and universities:
12. Professional networks

Vehicles and Mechanisms (Reflection of Constructions)

13. Workshops, institutes, courses, and seminars:
14. Technology for professional development:
15. Developing professional developers:

This research review shows that for a professional development designer to be effective, that awareness, knowledge, practice, teaching, and reflection are essential elements that need to be placed within a successful professional development program.

Aligning Strategies with PEPTYC Professional Development Model

While some people might be looking for a few discrete, clearly effective "models of professional development," disappointment will be the end result of their search (Kutner & Tibbetts, 1997, pg 15). None of these actually exist. Every situation is unique and every effort to create a professional development model seems to require its own unique flavor. However, recreating models from scratch need not be the case, as an understanding of the design model indicates there is a broad and deep base of information, research and personal wisdom that can be drawn upon to build successful professional development opportunities for science teachers. As Robert Beck Clark stated in his interview with the researcher (Clark 2000), "I really didn't search the literature, I just used my instinct and my conversations with colleagues when we created the program. We really followed the model that had been used for the PTRA (Physics Teacher Resource Agents) programs".

With the development of this list of strategies, an organization's professional development planner should examine these five main categories when designing professional development opportunities: immersion, curriculum, examining practice, collaborative work, and vehicles and mechanisms. This examination of these strategies and the design models that have been developed as a guide for professional developments' most effective creation has a research basis, and it can be drawn upon to build successful professional development opportunities for science teachers. According to (Eisenhower & Clearinghouse, 1998), it appears to be highly effective if developers selectively choose from these as their guide. The PEPTYC project used its May Institute to immerse its participants into both an inquiry approach to science and into the world of scientific research. The use of "experts in the field" for modern physics and quantum optics presentations gave credibility to the content and immersion of these topics. Alignment with curriculum was also done during the May Institutes as the dissemination of real time physics (Thornton & Sokolof 1997), workshop physics (Laws, 1997), tutorials in physics (McDermott, 1999), and via the creation of each of the instructors own activities. This process was actively done during the May institute portion of the project and assigned as "at home projects" as well. The third of the categories for implementing change is examining practice. Besides PEPTYC's cracker barrel discussions of various implementation processes, the peer support and conversations also lead participants to examine teaching practices in a number of unique cases. The fourth categorical strategy is related to collaborative work. Collaboration with other participants at the May Institute was paramount, as group assignments, room sharing, and "social" constructivism highlighted the laboratory work and the discussion sessions. Coaching and mentoring of the PEPTYC program was not only provided by facilitators but also by the peer group of participants themselves. During the follow-up activities at the biannual physics teachers meetings, professional networks were established as the group was welcomed to present and participate in the association's meetings. Finally, alignment for the vehicles and mechanisms category seemed to be overlooked, except in the fact that from each of the PEPTYC groups someone eventually was chosen to assist in later projects or lead workshops and projects at their own institutions. However, the overall time span of the project did allow each participant a great deal of time for reflection and assessment of their implementation of program philosophy and content. Each of these strategies has specific areas in which they are designed to cause teaching change or improve teaching effectiveness. The researcher found that even though the project founders, Clark and O'kuma, didn't intentionally follow these literature recommended paths toward change, their program aligned rather significantly with these fundamental elements. As such, each of these strategies for professional development will be discussed in the following section of the literature review.

Strategies for Professional Development and Teacher Change

Strategies that focus on developing awareness are usually used during the beginning phases of a change. The strategies are designed to elicit thoughtful questioning on the part of the teachers concerning new information. Sharing sessions and dialogs within the PEPTYC community assisted participants in developing awareness of content and techniques. Strategies that focus on building knowledge provide opportunities for teachers to deepen their understanding of science content and teaching practices. These strategies appear to be used during the PEPTYC instructional phases during both lecture and laboratory sessions. Strategies that help teachers translate new knowledge into practice engage teachers in drawing on their knowledge base to plan instruction and improve their teaching. These strategies appear to be applied to the laboratory and curriculum design phases of the PEPTYC May Institute. It was during these workshop sessions when the practices of classroom experiences were exchanged. Strategies that focus on practicing teaching help teachers learn through the process of using a new approach with their students. PEPTYC's at-home projects and the semiannual reports from participants, that were given at Texas AAPT Section meetings, provided a peer review of these implementations of the new approaches, as they were set in multiple teaching environments. As teachers practice instructional approaches in their classroom, they deepen their understanding. Sharing their success and failures was integrated into various parts of the PEPTYC process, especially in group sharing. Strategies that provide opportunities to reflect deeply on teaching and learning engage teachers in assessing the impact of the changes on their students and thinking about ways to improve. Annual reports were given to the project directors, as well as oral reports on the implementation process and its success at home institutions. Initially, the first project sessions included at-home visitations by the project administrators. This practice changed after initial evaluations were made during the introductory years. These strategies also encourage teachers to reflect on others' practice, adapting ideas for their own use.

Elements Key to Participant Success

Susan Loucks-Horsley and her contemporaries stated that effective workshops, institutes, courses, and seminars have several elements in common (S. Loucks-Horsley et al., 1998, p.86). One of these included having clearly stated goals. When leaders of effective workshops, institutes, seminars, and courses communicate with participants about the goals of the learning experience prior to and during the sessions, they receive input from learners before setting goals, so that the learning experience addresses the learners' needs.

Another important element is a leader or facilitator who also guides and supports the participants' learning, often by being a primary source of expertise or bringing in other information through readings, consultants, the participants' experiences and knowledge, and structured experiences. The trainer is a key to success of the training experience. A good trainer has expertise in the new skills or practice being introduced, experience in their use, and an understanding of how adults learn and the importance of supportive, risk-free learning environment. Experience with the ideas or practice being presented is particularly important, since teachers are highly critical of experts who "haven't been in the classroom in 15 years" and rightly so. The trainer must be a credible teacher, not necessarily a current teacher, who can help answer the teachers' very specific "what if…" questions. The philosophy of the PEPTYC program directors as described by Clark (2003) validates this element by "allowing peers to teach peers" and "avoiding professorial droning".

The third element is that of defined time frames, which are of certain duration (e.g., 8 a.m. to 3 p.m.) and certain frequency (e.g., once a week for 3 hours.). This element helps to establish a learning environment that is designed so that it is collegial for participants to learn from one another and from the leader of the session. In chapter 4 of this dissertation, the researcher will show a specific schedule of activities that were designed into the PEPTYC framework.

Workshops, Institutes, Courses, and Seminars

Although there are additional types of professional development activities, the opportunities that are afforded by professional developers known as workshops, institutes, courses, and seminars were focused on during this literature discussion. The cornerstone for the PEPTYC project was the "May Institute". Teacher institutes are intensive learning experiences that typically serve the purposes of substantive content and professional renewal. They may present new ways of thinking about school subjects or alternate methods of engaging students in learning. Whatever the emphasis, it is the intensity of study that most characterizes the institute as a professional development option. They offer focused, continuous investigation of topics or themes that cannot be explored in occasional workshops. Frequently, institutes run from one week to three weeks, providing time for reflection and assimilation of information in a setting conducive to collegial learning. Institutes feature time, space, and support for teachers who want to explore new frameworks, think about their jobs, and dedicate the time and effort required for change. These professional training sessions are structured opportunities for educators to learn from facilitators or leaders with specialized expertise, as well as from peers. These professional development sessions usually occur outside of the classroom and often bring together educators from different locations for common experiences and learning. They provide opportunities for participants to focus intensely on topics of interest for weeks (e.g., institutes) or for an extended period of time (e.g., courses). Workshops and seminars, however, tend to be offered for shorter periods of time and address more discrete learning goals, such as learning to use a particular set of lessons or try a new assessment strategy. The PEPTYC project was characterized by a combination of an institute, workshops and seminars. Since graduate credit was given for the program, it was also considered a course. A focus on characteristics of these designed activities is provided in the summary below.

Workshops are characterized by providing participants hands-on activities which allow them the time or opportunity to try out new ideas and new curricular materials. Seminars tend to be more oriented to sharing knowledge and experiences through discussions and reactions to others' practice or research results. Depending on the learning goals for a particular group, a professional developer might choose to combine one or more of these strategies, such as an intensive institute followed by a seminar series, which is precisely what the PEPTYC leadership team elected to do. When a workshop involves the development of new skills and behaviors, cycles of practice in the classroom should transpire. Furthermore, coaching and feedback are critically important to the training having a lasting impact (Showers & Joyce, 1982).

Underlying Assumptions

The use of the professional development strategy of workshops, institutes, courses, and seminars is based on certain assumptions about learning, teaching, and professional development. These assumptions (Loucks-Horsley et al., 1998) include the realization that *external knowledge is valuable*. Educators must constantly expand their knowledge of both their teaching fields and how to teach them. The structures of workshops, institutes, seminars, and courses provide teachers with opportunities to connect with outside sources of knowledge in a focused, direct, and intense way. Given the difficulty that two-year college faculty have with isolation and sometimes non supportive climates, workshops, institutes, courses, and seminars provide teachers with time away from their classrooms and the opportunity to reflect, think deeply, argue alternative explanations, interact with other educators, and practice new ideas and techniques in safe settings. Loucks-Horsley et al, (1998) asserts adults benefit from time spent as focused learners being guided through new material and helped to make meaning of it for their own growth and experience. If administrators are willing to support faculty efforts at the professional development program, a more positive and productive experience can occur for the professional teacher. According to Dr. Robert Beck Clark, (Clark, 2003) a smorgasbord of activities highlighted the efforts of the PEPTYC Program. He also noted the key element of "proposed administrative support". Each participant's institution was asked to provide travel and release time for the project's participants. Loucks-Horsley (1998) and her collaborators validate the assumption that *one size can fit all* doesn't traditionally prove itself successful at many levels. Because workshops, courses, seminars, and institutes are attended by groups of people, developers assume that a well-crafted learning activity can indeed meet the needs of many. Clark's assumption was that providing a "smorgasbord of activities" would at least help make the project somewhat successful for all involved. Individuals each bring something different to a learning experience and inevitably take away something different. This structure assumes that many can benefit from the same experience.

<u>Implementation Requirements</u>

Several requirements are generally necessary for professional development workshops, institutes, courses, and seminars to be successfully implemented. Facilitators of knowledge, or experts in the field, are the people who must be available to provide or facilitate access to the expert knowledge that learners will be exposed to during the sessions. The PEPTYC program provided research scientists, as well as curriculum designers and specialists, during their programs. Peer instructors who were from the two-year college community also provided additional program training and facilitation. To implement a successful training program, the designers must consider teachers' time away from the workplace. Included with this arrangement is assistance with substitute teachers, if required, or stipends for work produced off-site. Financial costs of providing quality professional development can be prohibitive. Most workshops and seminars meet during regular school hours and require that a teacher have a substitute for the classroom. Teachers usually participate in courses and institutes during nonteaching time (such as during the summer, evenings and weekends). For these sessions, teachers may be paid a stipend for their time. A quality professional development opportunity will provide learners with a curriculum guide, advanced organizer, or syllabus. Learners should know what content they will learn through the professional development experience. Courses offered with graduate credit also require prior review and approval of content. A curriculum guide or syllabus addresses these needs.

Today's information age makes access to resources and materials quite easy. This wasn't as simple in previous decades. When designing and implementing development activities which depend on the content of the course, workshop, institute, or seminar, classroom materials, student work, texts or articles are needed and must be readily accessible. Finally, implementation of a program is usually more successful when there are incentives. There are a variety of incentives that can be offered for participation. For example, teachers can be given stipends when time is taken beyond regular school hours. Teachers can also be rewarded for their participation in these learning activities through recognition and graduate or professional development credit. All of these incentives were available for participants of the PEPTYC Program.

Teacher Change

From research on teacher change, it is clear that a one-time workshop or seminar is unlikely to result in significant, long-term change in the practice of a teacher (Fullan, 1991; Joyce & Showers, 1988; Little, 1993). Rather, change requires multiple opportunities to learn, to practice, to interact using, and to reinforce, new behaviors. Thus, although a single workshop may be a good kick-off for learning, and can result in new knowledge or awareness on the part of participants, additional opportunities are needed for long-lasting change. Traditional evaluation practices don't allow someone to probe deeper into this idea of teacher change. This research will provide a deeper look into what type of changes might have been a product of the exposure to the PEPTYC institute and workshop activities.

Because stand-alone strategies like workshops, institutes, courses, and seminars fall short of providing a well-rounded professional development experience, ideally, one-time workshops, and even long-term courses, are combined with other strategies to enhance the learning experiences of the participants. As Robert Beck Clark put it in his interview, (Clark, 2003) "A sampling of many opportunities was hard to sell to the funding agency until we demonstrated the entire process of development we had planned." According to a Regional Educational Laboratories 1995 publication, simply attending a workshop on pedagogy is insufficient to equip teachers to alter their practices. Teachers also need opportunities to translate their learning into practice (e.g., through modifying their curriculum), implement the new knowledge (e.g., with coaching), and reflect on their practices (e.g., through case discussions). When the principles of effective professional development are incorporated into the design of workshops, institutes, courses, and seminars and are then combined with other strategies, such as those suggested previously, the benefits for teachers are strengthened. For optimal professional development, workshops, institutes, courses, and seminars must reflect the following features of effective adult learning as summarized below: (Laboratories, 1995)

- Opportunities for learners to shape the content of the workshops, institutes, courses, or seminars.
- Time for reflections, predictions, and exploration.
- Multiple modes of presentations and information processing.
- Support and feedback from people with expertise.
- Connections between new concepts and information and current knowledge and experience.
- A safe environment to try new ideas and approaches.

As will be seen in the section on data later in this dissertation, while each of these characterize optimal professional development practices, the leadership team of PEPTYC didn't research these ideas beforehand, they did, however, note most of these features as a part of their program design. While, the incorporation was not "planned", it did effectively find itself as part of the PEPTYC model.

Divergent Expectations as Barriers to the Diffusion of Innovations

Recently, Henderson and Dancy (2008) performed a study with the main purpose being an effort to understand the barriers to instructional change. The study was reported in a paper titled "Physics Faculty and Educational Researchers: Divergent Expectations as Barriers to the Diffusion of Innovations" Their premise for the study was related to the fact that the current models of the change process are not able to account for the slow rate of instructional change in college-level physics. The result of their study was to generate new categories of barriers for this change. Through exploratory interviews similar to those purposed for this study and according to diffusion-based change models, they determined that barriers existed which make teachers less likely to produce instructional change. While this dissertation research was being completed, Charles Henderson and Melissa Dancy were presenting the results of their on-going research during a series of AAPT Physics Education Research Conferences, which was discovered by the researcher after the initial literature review. Hence, these ideas were used to assist in the analysis of the acquired interview data.

An Adoption-Invention Continuum for Changing Teaching Methods

Henderson and Dancy (2008) proposed an adoption-invention continuum of how physics teacher act when being exposed to the prospectus of change. This continuum describes important characteristics of possible interactions between educational researchers and other faculty. Henderson and Dancy (2008) make and support the claim that many change agents operate on the adoption side of this continuum. The term change agent is used for all those persons or groups of persons, which are responsible for implementing change. Thus, it covers the function of the change agent in itself, as well as change managers, change leaders or project managers for change projects. Rosabeth Moss Kanter, (1999) provided a great summary of the characteristics of a good change agents when she wrote that the most important things a leader can bring to a changing organization are passion, conviction, and confidence in others.

Adoption-Invention Continuum

There are two important participants in the instructional change process. One is the instructors who are interested in or are being asked to change their instruction. The other, change agents, are curriculum developers or professional development providers who provide information, materials, encouragement, and mentoring to help the instructors as noted by Henderson and Dancy (2008). The instructors who were accepted into the PEPTYC project had an interest, while the change agents were Robert Beck Clark and Thomas L. O'kuma, the PEPTYC project leaders. These were two men who had passion, conviction and confidence in their peers to effect "significant physics teaching change" within the TYC physics teaching fraternity. From analysis of the interview data, end of project surveys, and personal testimonies, it appeared to this researcher that they have the correct characteristics of good change agents.

According to Dancy and Henderson (2007), there is a body of literature (Fullan, M. (2001); Rogers M.(1995); Ellsworth, B.(2000)), that explores how these two types of participants interact in the change process. Models of the change process typically include at least three activities:

(1) An instructor becomes aware of a problem with their current practice,
(2) An instructor develops knowledge about a new practice that can minimize or solve their current problem,
(3) An instructor implements the new practice.

There are three basic levels of knowledge that can be developed during the second phase:

- "awareness" knowledge (knowledge that the instructional strategy exists),
- "how-to" knowledge (basic knowledge about how to use the strategy properly),
- "principles" knowledge (knowledge about why the strategy works – essential for solving unexpected problems that occur during use).

Although much of the literature on educational change deals with instructional changes that are developed and disseminated by external change agents, it is important to note that innovations do not necessarily come from external sources but may be developed entirely by an instructor. The researcher believes this observation should be accounted for in theories of change.

Henderson and Dancy (2008) identified four basic categories of change that vary in terms of the roles of the external change agent and the instructor in the change process. These are the categories as described in the following Figure 1.

Adoption	**Adaptation**	**Reinvention**	**Invention**
The change agent develops all of the materials and procedures and gives them to the instructor to implement as is.	The change agent develops the materials and procedures and gives them to the instructor who modifies some of the details before implementation.	The instructor uses the ideas or materials of the change agent but changes them significantly (i.e. changes a principle or develops fundamentally new procedures or materials based on the change agent ideas.	The instructor develops materials and procedures that are fundamentally based on his/her own ideas.

Figure 1: Adoption Invention Continuum

The categories are not discrete. They tend to occur on a continuum. Henderson and Dancy (2008) found it useful to use these category labels to represent general locations along the continuum. Notably, the responsibilities of the change agent and instructor change significantly as one moves across the continuum. The researcher found that categorizing in this method was useful. Hence he followed a similar model when analysis of his data was completed.

Activity in the Change Process	**Adoption**	**Adaptation**	**Reinvention**	**Invention**
Identify and Instructional Problem	CA	Either CA or I	Either CA or I	I
Develop a general idea of a solution (awareness knowledge)	CA	CA	CA	I
Develop principles of the solution (principles knowledge)	CA	CA	I	I
Develop details of the solution (how to knowledge)	CA	I	I	I
Implement solution	I	I	I	I

Figure 2: Change Agent (CA) and Instructor (I) Roles in Developing and Implementing New Instructional Strategies

In an effort to describe this change continuum, one can see that to the far left of the scale the change agent develops all of the materials and procedures which are presented to participants in a professional development dissemination project. The curriculum material is given to the participants aka the "instructor" to implement as is. In its extreme, this end of the continuum represents a change agent view that the instructor is irrelevant. A view of the other extreme of the continuum shows that the instructor develops everything with minimal external influence. According to Henderson and Dancy (2008), in its extreme, this end of the process represents an “instructors” view that educational research is irrelevant. Under the middle two regions of the continuum, adaptation and reinvention, the general idea of a new instructional strategy comes from an external source, such as the change agents in the PEPTYC program, or their peer instructional colleagues, but the instructor is held responsible for developing important aspects of the instructional strategy. Although it is possible for an instructor to develop these aspects of the strategy with the assistance of a change agent, typically the instructor develops these aspects of the strategy on their own or during practical application periods of long-term workshops, institutes and seminars.

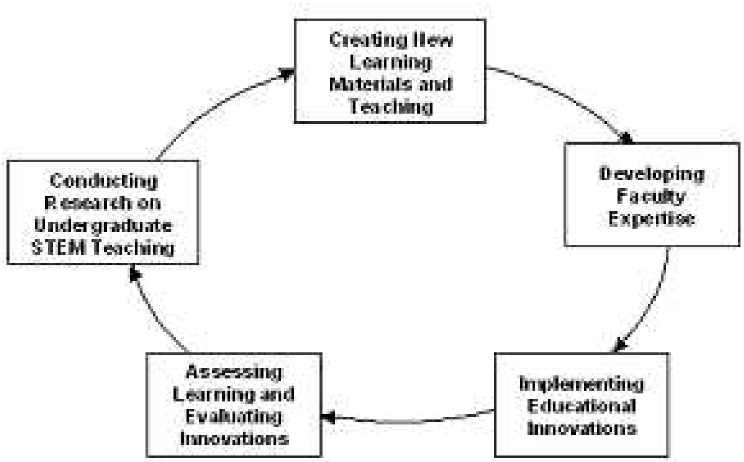
After reviewing the general goals of the PEPTYC program, it appeared to the researcher that it was the intent of their professional development program to expose the participants to materials and let them decide what practices and which processes would work in their own instructional setting. According to Henderson and Dancy (2008) these instructor-developed principles and details are not always consistent with “best practices” as identified in the educational research literature. Many of the Physics Education Research dissemination practices of specific curriculums haven’t taken the approach which the PEPTYC leadership described as the “Smorgasbord Approach”. The description of this approach is detailed within Chapter 4 and the data.

Change Agents Expect Adoption/Adaptation

What are the expectations that physics faculty have about their interactions with change agents? First, one must examine the expectations that change agents have.

Although there are certainly a wide variety of change agents with a wide variety of expectations, it appears that most Physics Education Research change agents operate near the adoption/adaptation end of the continuum. This is according to the assumptions that Henderson and Dancy (2008) made in their research report.

This is evident in much of the discourse near the adoption/adaptation end of the continuum related to educational change that focuses substantial efforts on developing and testing specific instructional innovations. Once proved successful by their Physics Education Research developer, these Physics Education Research innovations are then disseminated to instructors who are expected to use them with fidelity. The instructor is not an important part of the development of these strategies and, in fact, is often considered to be a barrier to educational change. As an example, consider the model of curriculum development and dissemination advocated by the NSF-CCLI program



Cyclic model for knowledge production and improvement of practice in undergraduate STEM education

FIGURE 3: NSF CCLI model of educational change. [From Ref. 37]

(Figure 3).

This model shows the change agent responsibilities as conducting research, developing materials and then helping faculty develop expertise in using these materials. There is nothing inherently wrong with this perspective. A change agent might imagine that the adoption model would be most effective since it places much of the burden on the change agent to develop innovative strategies and materials. This takes considerable time and expertise that typical faculty may not possess. Henderson and Dancy (2008) assert that it would be reasonable to assume that faculty expects this sort of interaction with educational researchers. In addition, the adoption model is important for researchers who are attempting to determine the efficacy of a new instructional method. It is difficult to draw conclusions unless the entire participating faculty is doing more or less the same things. The PEPTYC model really has a fundamentally different piece of this puzzle at its focus; PEPTYC wasn't attempting to conduct research regarding the effectiveness of curriculums on undergraduate STEM teaching. Rather, the change agents were more interested in displaying the research projects of many Physics Education Research innovators rather than the promotion of a single "one size fits all" approach.

In spite of these reasons from the change agent perspective that support change agent-instructor interactions on the adoption/adaptation end of the continuum, it is important to understand how instructors perceive their actual and desired interactions with change agents. It appeared that the PEPTYC program was interacting in the middle of this continuum rather than on either end, a different perspective than the Dancy and Henderson (2008) research asserts.

Faculty Attitudes toward Teaching and Professional Development

Finkelstien (2004) considered physics faculty attitudes and beliefs about teaching and learning. According to Finkelstein (2004), it is generally acknowledged that instructors' attitudes and beliefs have a major impact on classroom practices and consequently, on student learning (De Souza Barros & Elia, 1998; Pajares, 1992; Peterson & et al., 1989; Richardson, 1996). For instance, Gunstone and White note that university teachers' views of the structure of physics were overwhelmingly the dominant criteria for deciding curriculum and pedagogy (Gunstone & White, 1998). Instructors' beliefs about teaching and learning are formed by personal experience, experience with schooling and instruction, and experience with formal knowledge, including pedagogical knowledge (Richardson, 1996). Many beliefs about teaching and learning are established early and are strong and enduring (Pajares, 1992; Richardson, 1996). Instructors' attitudes and beliefs about teaching and learning are particularly relevant in physics, where those attitudes and beliefs may constrain widespread use of the findings of physics education research. Robert Beck Clark stated during one interview with the researcher (Clark 2000), "I suppose that the original group was less likely, or even less willing to change, because it would be difficult, some of us "Neanderthals" really are set in our old ways."

While physics education research provides guidance on effective instructional practices, it rests on a particular set of assumptions about teaching and learning that may be at odds with an individual instructor's beliefs. Despite evidence that interactive engagement methods are more effective than traditional instruction, (Hake, 1998) enthusiasm for using interactive techniques varies widely among instructors. Clark

(2000) also noted, “I think that many of the participants are now much more likely to try the active learning techniques than they were 12 years ago.” Finkelstein’s research (2004) attributes this, in part, to differing attitudes and beliefs about teaching and learning. Other constraints might include lack of resources, institutional support, or awareness (Dancy & Henderson, 2004). For example, interactive techniques generally aim to improve the performance of all students, particularly middle- and low-achieving students. If the instructor believes the purpose of the course is to ‘find out who’s good at physics’ (as opposed to bringing all or most of the students to a particular level of competence), then he or she may feel that interactive techniques undermine the instructional goals. Additionally, if an instructor believes that physics is either something you ‘get’ or you do not, then he or she may not feel interactive techniques are worthwhile. Finkelstein (2004) considers instructors’ beliefs and attitudes about teaching and learning of central importance to widespread implementation of physics education research and its curricular reform efforts.

Faculty Attitudes about Research on Teaching and Learning

Because of the undergraduate and graduate science disciplinary training one might conclude that community college physics faculty are experts at using research methodologies to study physical phenomena. However they may not possess commensurate expertise in education. While most physicists are able to transfer the researcher paradigm of thinking to other scientific fields, they are not necessarily able or willing to transfer these attitudes toward physics education. Finkelstein (2004) points out that most university physics faculty are unaware of physics education research. They are oftentimes skeptical of whether physics education research is valid or productive.

Finkelstein (2004) continues to state that these attitudes are symptomatic of university physics faculty beliefs about teaching and learning in general. For instance, Gunstone and White (1998) found that faculty tends to adopt a content-centered rather than a student-centered approach to teaching. Finkelstein (2004) purports, these attitudes and beliefs, while strongly held by university professors, reflect the broader culture of physics teaching. The university physics culture often focuses exclusively on research in physics to the detriment of other professional aspects, such as teaching, with adverse consequences for the entire physics community.

In general, research and teaching are seen as separate endeavors that do not inform each other. This attitude is a common cultural feature of university physics instruction. This researcher focuses on how PEPTYC prepared the community college faculty to address the aforementioned detrimental aspects of physics culture toward teaching and continue to develop professionally as teachers. Because of the unique set of circumstances that are the "two-year college" teaching profession, Finkelstein's assumptions have possible exceptions within the two-year college physics teaching paradigm.

Professional Development Evaluation

Most people agree that evaluation of professional development is necessary, yet there are few attempts to do more than measure 'happiness coefficients' at the completion of workshops (Loucks-Horsley, et al., 1987). With more and more calls for accountability, and with far too few resources, staff developers are calling for approaches to evaluation that are practical, useful, and rigorous enough to be believed. Although the PEPTYC Project was evaluated both internally and externally, the research being done here is an effort to evaluate at a deeper level than was required by the funding agency of the program. Thomas Gusky (2000) stated, “Good evaluations do not require a large amount of technical expertise—only the ability to ask good questions and know how to go about finding valid answers.” According to his textbook, some essential questions about the evaluation process for staff development programs include:

- What outcomes should be evaluated?
- Who cares about the evaluations?
- Who are the audiences?
- What are the purposes for the evaluation?
- What major activities and decisions should be included in the evaluations process?
- Who should participate? And in what ways?
- How do we know what it all means?

This researcher’s assumption is that the purpose of evaluation is to aid decision making abut the future of the program, i.e., its uses, changes, and resources needed at any given time. These assumptions were also held by the principle investigators of the PEPTYC program when they made decisions about the direction their program would head. The researcher needs information regarding program processes and program effects to assist him in the additional levels of evaluation that are proposed within this research. These questions appeared to be asked and answered by the PEPTYC program evaluation reports. Determining additional outcomes and long term effects were not the intention of the program’s previous evaluation.

What Professional Development Outcomes Need to be Evaluated?

A variety of goals and associated outcomes have been proposed as important and legitimate outcomes from professional development. They range from student outcomes to teacher outcomes to organization outcomes. They also range from changes in attitudes and beliefs to changes in skills and behaviors. Depending on the nature of the outcome, data collection and measurement strategies will vary. The researcher proposed to evaluate behavior change and effective and ineffective reactions of a long-term program, and after an extended period of time had passed since its completion. This research study investigated changes in participants, changes in organizational capacity and changes in students.

Change in Participants:

Some possible changes to measure in a research study would include changes in the participants, which are the most direct and immediate outcomes of a professional development program; thus they are the easiest to document, measure, and relate to program activities. Changes in participants might include changes in their knowledge base, their skill level and use, and their attitudes, opinions, and feelings. Probing questions through a series of interviews can provide a closer look at these changes.

Change in Knowledge:

Most professional development programs intend to increase the knowledge of participants. Pre- and post-testing would provide information on knowledge outcomes, as would self-reports though surveys and interviews. Many of these activities were addressed in the initial evaluation process completed by the internal and external evaluators of the project.

Change in Skill Level:

Reports of changes in participants' skill level and use were often shared during follow-up sessions for the PEPTYC Program. Acquiring new skills and using new practices are often key outcomes of staff development programs. Participants learn new teaching skills, techniques, or strategies that they use with their students. To document skill acquisition and use, Ellis (1982) suggests a self-assessment checklist, which asks teachers to indicate how well they thought they had learned the skills. Interviews, observations of teachers using the skills or practices, and clinical supervision or coaching discussion notes would also provide independent information on how well teachers had learned and were using the target skills. Examining skill level will be incorporated as a part of the interviewing process that will be highlighted in the methodology chapter of this research work.

Change in Practice:

Loucks and Melle (1982) suggest collecting information on the use of various components of the new practices teachers are implementing. They suggest using the Concerns-Based Adoption Model (CBAM) to help focus the evaluation study.

Concerns-Based Adoption Model (CBAM)

A number of researchers mentioned that one model for change in individuals, known as the Concerns-Based Adoption Model, applies to anyone experiencing change, including, policy makers, teachers, parents and students (Hall & M., 1987; Hord, Rutherford, Huling-Austin, & Hall, 1987; Louck-Horsley & Stiegelbauer, 1991). Accordingly the CBAM Model is another framework that has implications for the practices of professional development. It acknowledges that learning brings change, and supporting people in change is critical for learning to "take hold." The concerns model identifies and provides ways to assess stages of concern; these stages have major implications for professional development.

First, they point out the importance of attending to where people are and addressing the questions they are asking when they are asking them. Second, this model suggests the importance of paying attention to implementation for several years, since it takes at least three years for early concerns to be resolved and later ones to emerge. Teachers need to have their self-concerns addressed before they are ready to attend hands-on workshops. Teachers have management concerns that can last for an extended period of time. This is especially true if a teacher is implementing a school year's worth of new curricula. Supporting a teacher during the time of implementation is necessary to reinforce good teaching once its use finally becomes routine. Finally, a method to assess whether and in what ways students are learning needs to be supported as well.

Professional developers, who know and use the concerns model, design experiences for educators that are sensitive to the questions they are asking when they are asking them. According to the CBAM model, the following checklist of concerns must be addressed:

(1) The first is the concern of the relation to learning experiences and how they evolve over time, take place in different settings, rely on varying degrees of external expertise, and how they change with participant needs.
(2) The second is the concern over how learning experiences vary by who provides them, what information they share, and how participants are asked to engage.

The strength of the concerns model is in its reminder to pay attention to individuals and their various needs for information, assistance, and moral support.

'Levels of Use' Dimension

Loucks and Melle (1982) suggest that the 'Levels of Use' dimension of the CBAM model can provide helpful techniques and strategies for measuring and evaluating what teachers do with their newly acquired knowledge and skill. CBAM evaluation information is collected through focused interviews or surveys which, when analyzed, can provide systematic, useful information for individuals or groups of teachers.

Change in Attitudes, Opinions, and Feelings:

Changes in attitudes, opinions, and feelings are an important addition to the more observable outcomes discussed above; professional development programs may strive for more amorphous effects on the attitudes, opinions, and feelings of participants. The framework for evaluation, which is discussed later in this literature review chapter, addresses the level of evaluation where this can occur. Participants' individual satisfaction with the activities themselves is the most frequently measured outcome of professional development programs. The PEPTYC Leadership group used these traditional workshop evaluation forms to measure the immediacy of success. While useful, measurement of immediate satisfaction with a training event is not enough. There are many other long and short-range changes in attitudes and feelings that are legitimate and beneficial outcomes of staff development programs, which can be examined in a research project like this one. Some suggestions follow.

Teacher Interest:

Inquiring about raising teacher interest and concern in a topic is something evaluators may want to study. Asking the question, is the teacher developing more favorable attitudes toward specific practices or perspectives embodied in the professional development program? is found in the CBAM, 'Stages of Concern'(Loucks & Melle, 1982). Here, the specific concerns teachers have about applying their new skills in the classroom are the focus.

Community and Ownership:

Building a sense of community and ownership of the program is one concern. The program may contain specific strategies intended to build a sense of community among participants and a sense of ownership in their school's professional development program.

Participants' Sense of Efficacy:

Evaluators may want to investigate whether the training program is resulting in an increased sense of confidence or efficacy with respect to specific ideas or more generally, with respect to prospects for doing a good job.

To assess the above outcomes, in this project the researcher interviewed and surveyed participants about their perceptions of changes in attitudes and feelings several years after they had completed the PEPTYC project.

Change in Organizational Capacity:

Sometimes professional development programs strive to make a difference in the overall capacity of the organization through increasing collaboration or expanding the roles of participants. From the perspective of this project, the "organization" refers to the community of two-year college physics faculty who attended the PEPTYC meeting.

Increasing Collaboration/Collegiality:

Evaluators may be looking for a demonstrated ability and willingness among participants to work collaboratively or collegially to improve classroom or school practices. This outcome is likely to involve improved willingness to examine, alter, or abandon old practices and test new ones, and to expose one's knowledge, skills, and experiences to the scrutiny of others.

Expanding Roles of Participants:

Little (1982) also suggests that expanded or altered role definitions or role relationships that improve the odds of classroom and school success are legitimate outcomes of professional development programs. Assessment of changes in organizational climate is unlikely to be very quantifiable. Such changes can seldom be meaningfully reduced to numbers. However, qualitative impressions and perceptions of trends can be drawn from surveys and interviews, providing feedback on progress toward these goals.

Changes in Students:

When teachers are trained to do something new or different in the classroom, it is presumed to result in specific kinds of student outcomes. Decision-makers often want information on student progress related to the new practices and techniques teachers are learning.

A variety of measures may be appropriate to evaluate student outcomes, including formal and informal test scores, student products, surveys, observations, and interviews. While these outcome measures may be relatively easy to collect, it may be difficult to draw causal connections between professional development activities and student performance, especially if the student performance standards are not explicitly articulated within program activities. It takes time for significant student change to be readily observable as a result of staff development. The studies on change conducted by the Rand Corporation, to study the impact of educational innovations funded through Federal programs, estimate that it takes three to five years for the change to truly "take hold" (Berman & McLaughlin, 1978). Therefore, the timing of the current study, vis-à-vis the completion of the PEPTYC program in 2003, is appropriate.

A Summary of the Evaluation Framework

Professional developers should begin to plan their programs by considering the desired results. A major challenge is to present the professional development program in a way that enables the participants not only to learn what they need to know but also to react favorably to the program. According to Kirkpatrick (1959), the four levels of evaluation are considered as follows: First, the researcher evaluates the knee-jerk reaction of the participants, secondly, he evaluates learning, followed by behavior, and lastly, results—in that order. Each of the four levels is important, and as a researcher, he should not bypass the first two in order to get to levels 3 and 4. Reaction is easy to do and should be measured for every program. Program facilitators and evaluation staff should proceed to the other three levels as staffing, time, and money are available. Oftentimes, money, staff and time are not available and very little effort is put into these deeper levels of evaluation.

Kirkpatrick's Model for Evaluation of Training/Professional Development

In evaluating faculty and staff development, according to Guskey (2000), one of the best models was advanced by Kirkpatrick (1959, 1977, 1978). Thomas R. Guskey notes the reference to this claim in his book *Evaluating Professional Development* (Guskey, 2000), “Steaming from a very different research tradition but having direct relevance for educators is the evaluation model developed by Kirkpatrick. It was designed to judge the quality, efficiency, and effectiveness of supervisory training programs in business and industry.” Kirkpatrick outlined a four-level evaluation model. These four levels represent a framework or sequence of ways to evaluate programs. Each level is singularly important and has an impact on the next level as an evaluator moves from one level to the next. Kirkpatrick (1978) maintains that the process becomes more difficult and time-consuming, but it also provides more valuable information.

Kirkpatrick’s model is used in business and industry in which the training office is a cost center and must sell its services to operating units. Although it is a business model, it can be adapted to the field of education and applied to the evaluation of professional development institutes. The model is tiered, with four distinct levels. A broader philosophical understanding of the four levels of evaluation, as stated by Kirkpatrick in his model, need to be examined by the researcher. The researcher suggests an expansion based on an education-based visionary perception of Kirkpatrick’s basic framework, which mirrors some of the features of Kirkpatrick’s model, but also builds on it in light of more recent theories of conceptual change, learning and transfer. This researcher believes that the perspectives afforded by these theories offers a substantial addition to Kirkpatrick’s framework, especially in educational context as viewed through an educational lens. Descriptions of the Kirkpatrick’s four levels with these additional views follow.

Level 1: Reaction

According to Kirkpatrick's model, the first level is known as reaction. As the title word implies, it is a measure of how participants in the program react to it. The first level of evaluation focuses on the knee-jerk nature of participant reaction; that is, it consists primarily of the reactions or feelings of the participants at the end of an activity. Because training programs in business and industry are generally designed to help those who participate, it is important to determine how satisfied they are with the training they receive. Kirkpatrick's business model called it a measure of customer satisfaction. In business and education, getting any reaction, including a positive reaction, to your program is essential. The ratings received often have more to do with the timing of the activity or how participants reacted to the instructor's personality than anything else. If the professional developer believes that sustaining a program in the future depends on positive reaction, then a negative, non-favorable, reaction by the participants probably will lead to a lack of motivation to learn. Negative reactions can almost certainly reduce the possibility of learning occurring, but positive reaction does not guarantee learning either. The reaction level will generally determine the satisfaction level of the participants in the program. Kirkpatrick's (1959) model provides an appropriate starting point when considering the evaluation of training and professional development programs. The researcher believes that the term attitudes should be included as a sub heading of the reaction level.

Attitudes:

In evaluating the attitudes of the participants after they have completed the workshop one can see the participants' views are more encompassing than merely their knee jerk reactions to the workshop. For instance, the workshop might improve the participants' attitudes about teaching and learning in a community college. Building positive attitudes can have a desirable effect on what the participants learn at the workshop and transfer to their teaching setting. Thus, the first level really goes beyond merely evaluating the superficial reactions of the participants to the training experience, and tries to evaluate the impact of the professional development experience on their attitudes toward teaching and learning.

Level 2: Learning

Kirkpatrick's second level of evaluation is called learning. Learning can be defined and then measured as the extent to which teaching professionals change attitudes, improve their knowledge base and/or increase skill as a result of attending the program and participating in its activities. Those are the three things that a professional development program can accomplish. Programs dealing with topics like learning styles and student diversity in the classroom aim primarily at changing teacher attitudes. Technical programs that incorporate computer use in the classroom aim at improving skills. Some professional development programs focus on topics like leadership skills, teacher and student motivation, and communication. These programs can aim at all three objectives.

Evaluation at level two asks the question, "Did any learning occur?" In order to evaluate an instructor's level of learning, the specific objectives must be determined. Some evaluators say that no learning has taken place unless change in behavior occurs. In the four-leveled model described by Kirkpatrick, learning has taken place when one or more of the following occurs for the professional development participant: their knowledge is increased, skills are improved or attitudes are changed. Normally, to do an adequate job of measuring or determining this, it is necessary for a project evaluator to conduct some sort of pre- and post-testing data collection activity. The principle investigators of the PEPTYC project conducted evaluation surveys after each year of the program, as well as a preliminary survey of ideas and goals before the training institute began. Because most training programs are trying to increase knowledge and skills or change attitudes, evaluation at this level centers on how effectively the programs accomplished these learning objectives. Hence, in the Kirkpatrick model, the second level is evaluating the learning by the participants that occurs in the workshop. The definition of 'learning' via an educator's eye expands on the definition of 'learning' as it was used in the Kirkpatrick's model.

Epistemology:

In Kirkpatrick's model, learning referred primarily to the acquisition of skills and strategies to complete a task in a business environment. This researcher believes that with regard to professional development of faculty, learning should refer to the changes in which they view the process of teaching and learning, and their role as a teacher. This type of learning goes beyond learning a few teaching strategies and techniques. Rather, it involves reflecting on which techniques are applicable in which situations, and how to balance different approaches to teaching and learning. Thus, the 'learning' level encompasses more than acquisition of skills and strategies to complete a task. Instead, it refers to a newfound wisdom about teaching and learning. This wisdom is considered to be a philosophical or an epistemological change.

Assimilation:

When viewed from the perspective of cognition, a significant difference between a business approach and an educator's approach occurs with regards to the way in which each evaluator thinks about 'learning.' In Kirkpatrick's model, 'learning' is similar to what is referred to as 'assimilation' of new strategies into the participants existing schema or model of their role and responsibility in the organization. The participant might learn new strategies and techniques to help them do the task more efficiently and effectively. Businesses are often driven by a top-down chain of command which requires their employees to fill a predefined role and complete a set of tasks well. For such employees, the professional development or training program provides a set of tools that they can use to become more efficient or effective. They are not required to be reflective about what they do and why they do it.

Accommodation:

Viewing 'learning' through an educator's lens is similar to what is referred to as 'assimilation' as well as 'accommodation.' While the former refers to the addition of instructional strategies and techniques into the participants' repertoire, the latter refers to a change in their schema or model of teaching and learning. For instance, a participant may assimilate a new technique such as discourse management to use in their classroom. However, without adequate thought and reflection about the ways in which this technique can be used; when it is most productive; when it is not productive; and what its advantages, disadvantages and limitations are; the participant would not have completely accommodated this technique into their model of teaching and learning. Thus, viewing the Kirkpatrick model through our educational lens, specifically evaluates whether or not the new ideas and strategies learned through the professional development experience have been accommodated into the participant's schema of teaching and learning.

<u>Level 3: Behaviors</u>

Behavior can be defined as the extent to which change in one's actions has occurred because the participant attended the training program. Project evaluators rarely attempt to evaluate the more sophisticated level three, known as behavior evaluation, primarily because the evaluator attempts to determine if there have been any changes in behavior that can be attributed to the activity. This considers the extent to which the on-the-job behavior of participants changed because of the training. The focus at this level is on how much and what type of change actually took place in job performance. The outcomes from this level of evaluation are often surprising. Kirkpatrick (1959) suggests that it is not uncommon to find that assumed learning from a professional development activity has not been followed by an observable and measurable change in behavior. According to Kirkpatrick, changes in levels 1 and 2 must take place if a change in behavior is to occur. If an evaluator fails to look at levels 1 and 2 and draws the faulty conclusion that no behavior change occurs, the obvious conclusion is that the program was ineffective and that it should be discontinued. A conclusion like this may or may not be accurate since a reaction may have been favorable, and the learning objectives may have been accomplished but the level 3 or 4 conditions may not have been present.

In the eyes of an educational professional this level is an evaluation of the transfer of learning. Evaluating the extent to which the participants have been able to transfer what they have learned from the professional development experience to their classroom parallels behavioral actions. At this level our evaluation process extends beyond

Kirkpatrick's model in an important way. In Kirkpatrick's model, the third level is 'behavior'. Evaluation at this level focuses on the ways in which the professional development or training experience has altered workplace behaviors. The change of behavior, however, does not automatically imply a change in thinking. Participants might change their behavior without necessarily changing their underlying thinking. The focus is on transfer of learning, and not only on change of behaviors, but on the extent to which the learner has been able to transfer what they have learned in the professional development experience to their teaching setting.

Transfer of Learning:

Transfer of learning is most simply defined as applying what one has learned in one context to another context. Transfer has been widely studied in literature (Gick, 1980; Reed, Ernst, & Banerji, 1974) and has often been deemed to be rare. More recently, researchers (Rebello et al., 2005) have expanded the way in which they think about transfer. Bransford and Schwartz (1999) talk about transfer in terms of 'preparation for future learning'. They argue that transfer is not merely applying what you have learned, but also preparing yourself to continue learning in the new context. It is this expanded view of transfer that the researcher seeks to evaluate. An analysis of the preparation of the participants after the workshop to modify, create new curriculum, make changes in their existing teaching pedagogy that will be assessed in the research context.

Application of Learning:

Using Kirkpatrick's model, as seen through an educational professional's point of view, focuses the evaluation on whether the professional development experience has enabled the participants to develop the ability to be continuous learners in their own teaching setting. The hope is that they can become adaptive problem solvers – not merely teachers who will apply a few known strategies to their teaching, but those who will learn to adapt with the changing demands of their students and society. The evaluation model seeks to investigate the extent to which the professional development experience has changed the participants' model of teaching and learning and the extent to which they are able to apply and adapt this model to new teaching scenarios.

Level 4: Results

The fourth and highest level of evaluation has to do with the effective outcomes that are obtained as a consequence of the behavioral changes evaluated in level three. In business it is designed to assess the bottom line, such things as improved productivity, improved morale, lower turnover, and ultimately, more profits and better service. Uniquely enough, it is entirely possible that there may have been a positive reaction to the activity, learning may have occurred, and there may have been a change in behavior, and yet, there is little or no demonstrable change in the results accomplished. Kirkpatrick's model was designed specifically for professional development and training programs in businesses. Therefore, the results tend to focus on the bottom line of the company. If viewed from an educational perspective, the results from Kirkpatrick's model focus on the educational outcomes and on student learning. The evaluation will focus on the extent to which the professional development program has positively influenced student learning in the classroom because of its effects on the instructor.

In the following section we address some of the criticisms of Kirkpatrick's framework and describe how using his model via this educational perspective addresses some of these criticisms.

Addressing Criticisms of Kirkpatrick's Framework

Although Kirkpatrick's model has been applied widely in numerous settings, it has seen limited use in education because of inadequate explanatory power. It is helpful in addressing a broad range of "what" questions but lacking when it comes to explaining "why" (Alliger & Janak, 1989; Holton, 1996). Even though the model has been limited in educational use, its foundations seem to attempt to evaluate at a deeper level than previously done by the PEPTYC project evaluation team. This researcher feels it will be a useful model to adapt for this research work and has built upon it, to develop the framework for the evaluation of the PEPTYC project.

Kirkpatrick's Model: Modifications Include a Needed Additional Level

A number of modifications to Kirkpatrick's model have been suggested since it was originally described (Bernthal, 1995; Newstrom, 1978). For example, several researchers have recommended adding a fifth level to reflect training's ultimate value in terms of organization success criteria, such as economic benefits or human good, (Hamblin, 1974) and societal value (Kaufman & Keller, 1994). The framework addresses the connection to 'societal value' (Kaufman & Keller, 1994) and 'human good' (Hamblin, 1974) by focusing on the educational results of the training program, as opposed to the bottom line of the institution. The latter is more applicable to a for-profit company than an educational institution. However, the expansion of the framework does not assess the impact of the professional development program in terms of the organizational success criteria, because the 'organization' in this case refers not to a specific educational institution in which the program is delivered, rather, it refers to the larger community of community college physics faculty.

<u>Implied Causal Relationships</u>

The model has also been criticized by those who argue that the implied causal relationships between the levels have not been demonstrated by research (Alliger & Janak, 1989). This researcher believes that the educational perspective in using this framework addresses this criticism. By viewing the levels in the Kirkpatrick's model as demonstrated in Table 1, the framework captures causal relationship between the various levels as follows. The attitudes (level 1) of the participants emerging from the professional development program go beyond knee-jerk reactions to the program. To a certain extent the attitudes reflect their attitudes toward teaching and learning. Therefore, the participants' attitudes directly affect what they have learned from the professional development program (level 2). Similarly, while 'learning' in Kirkpatrick's framework focused primarily on acquisition of knowledge and skills, the term 'learning' in the framework refers to a deeper conceptual change about the process of teaching and learning. 'Behavior' in Kirkpatrick's model refers to whether the participants can apply or replicate the skills in the context of their home organization. But, 'transfer' (level 3) in the educational foundational framework refers to more developed conceptual model about teaching and learning that the participants bring to bear on their role as a physics instructor in their community college. Therefore, the causal link between 'learning' (level 2) and 'transfer' (level 3) from the eyes of an education framework is much stronger than the causal link between 'learning' and 'behavior' in Kirkpatrick's business-based model. This is true, since it is possible to change external behaviors in response to organizational demands or extrinsic reward without necessarily internalizing the change in terms of a conceptual model of teaching and learning. Finally, the 'results' in Kirkpatrick's model refer to the 'bottom line' of the organization, the 'educational results' (level 4) in our more focused model refer specifically to the impact on student learning. The greater focus on student learning ('educational results') in level 4 of the framework provides for a stronger causal link with the preceding level, which focuses on the extent to which the participant faculty can 'transfer' (level 3), explicitly adapt what they have learned in the professional development program to the context of their own institution. In summary, the evaluation framework addresses an important criticism in literature about the lack of a causal chain between various levels of Kirkpatrick's business based evaluation framework.

A Taxonomy of Outcomes

Others' criticisms of the Kirkpatrick model point out that it is not an evaluation model at all but rather a taxonomy of training outcomes (Holton, 1996). Nevertheless, its simplicity and practicality have made it the foundation of training program evaluations in businesses around the world. The framework, when viewed from an educational perspective, which builds on Kirkpatrick's model, is specifically focused on educational professional development programs and is more in line with current theories of conceptual learning and transfer. Based upon this framework and the observation that the evaluations that were done by both the internal and external evaluation team for the PEPTYC Project, the researcher is undertaking this project to focus on the final two levels of evaluation. According to Kirkpatrick, (1978) "None of the levels should be bypassed simply to get to the level that the trainer considers the most important." (Kirkpatrick, 1996). Professional evaluators are occasionally complacent when it comes to analysis of all four levels, but this researcher will be diligent in using the four-level framework to inform the evaluation study.

Table 1 Framework Comparisons

Kirkpatrick's Model A four tier business training evaluation model (limited use in education)	**Educational Framework** A four tier educational evaluation model (adapted from Kirkpatrick's Model)
Level 1 Reaction Immediate responses to the training received in the professional development experience.	*Level 1 Attitudes* Attitudes toward teaching and learning developed through exposure to the program
Level 2 Learning Learning refers to knowledge is increased, skills are improved and attitudes are changed.	*Level 2 Learning* Learning refers to deeper conceptual change about the pedagogy and the roles of teachers and learners.
Level 3 Behavior Extent to which the professional development or training experience changes what people do on the job	*Level 3 Transfer* Extent to which the professional development changes the way participants think about their own teaching and how they continue to grow as teachers
Level 4 Results The effect the professional development or training has on the bottom line of the company	*Level 4 Educational Results* The effect the professional development of the faculty has on student learning in the classroom

Kirkpatrick's Conditions Necessary for Change

Kirkpatrick contends that in order for change to occur, the person must meet four necessary conditions.

(1) Desire for Change: They must have a desire to change. They must be somehow dissatisfied with the way things are. This idea is related to the notion of cognitive dissonance (Festinger, 1957) that several researchers

(Piaget, 1995) have used to motivate the need for conceptual change. When individuals realize that their existing model of teaching and learning does not 'work' they are more likely to change the model.

(2) Strategies for Change: They must know what to do and how to do it. They must have alternatives to do things differently from before. This idea is related to the notion of model development (Hestenes, 1987). Change implies that participants develop and modify their model about teaching and learning. To develop a new model of teaching and learning, participants must learn new strategies and techniques and accommodate these new ideas into their existing model. The process is facilitated through guidance by more experienced peers such as the individuals who facilitate the professional development experience. These individuals guide the participant toward constructing this new model of teaching and learning.

(3) Climate for Change: They must work in the right climate for the change to occur and they must be rewarded for changing (Kirkpatrick,1978). A professional development program can accomplish the first two requirements by creating a positive attitude toward the desired change and by teaching the necessary knowledge and skills. The third condition, right climate, refers to the participant's immediate supervisor or place of employment. Five different kinds of climate have been described in Kirkpatrick's framework:

A Preventing Climate: The supervisor forbids the participant from doing what he or she has been taught to do in the professional development program.

The supervisor may be influenced by the organizational culture established by top management. Or the administrative leadership style may conflict with what was taught.

A Discouraging Climate: The supervisor doesn't say, "You can't do it," but he or she makes it clear that the participant should not change behavior because it would make the administration unhappy. Or the supervisor doesn't model the behavior taught in the program, and this negative example discourages the subordinate from changing.

A Neutral Climate: The supervisor ignores the fact that the participant has attended a professional development program. It is business as usual. If the subordinate wants to change, the administration has no objection as long as the job gets done. If negative results occur because behavior has changed, then the supervisor may turn into a discouraging or even preventing climate.

An Encouraging Climate: The supervisor encourages the participant to learn and apply his or her learning on the job. Ideally, the administrator discussed the program with the subordinate beforehand and stated that the two would discuss application as soon as the program was over. The supervisor basically says, “I am interested in knowing what you learned and how I can help you transfer the learning to the job.”

The Requiring Climate: The supervisor knows what the subordinate learns and makes sure that the learning transfers to the job. In some cases, a learning contract is prepared that states what the subordinate agrees to do. This contract can be prepared at the end of the professional development session, and a copy can be given to the administrator. The supervisor sees to it that the contract is implemented. An excellent description of this process can be found in Malcolm Knowles's book *Using Learning Contracts* (Knowles, 1986).

(4) Rewards for Change The fourth condition, rewards, can be intrinsic (from within), extrinsic (from without), or both. Intrinsic rewards include the feelings of satisfaction, pride, and achievement that can occur when change in behavior has positive results. Extrinsic rewards include praise from the boss, recognition by others, and monetary rewards, such as merit pay increases and bonuses.

It becomes obvious that there is little or no chance that professional development will transfer to job behavior if the climate is preventing or discouraging. If the climate is neutral, change in behavior will depend on the other three conditions just described. If the climate is encouraging or requiring, then the amount of change that occurs depends on the first and second conditions.

Formula for Change

The Formula for Change was created by Richard Beckhard and David Gleicher and is sometimes called *Gleicher's Formula*. This formula provides a model to assess the relative strengths affecting the likely success or otherwise of organizational change programs.

$$D \times V \times F > R$$

Three factors must be present for meaningful organizational change to take place. These factors are:

- **D** = Dissatisfaction with how things are now;
- **V** = Vision of what is possible;
- **F** = First, concrete steps that can be taken towards the vision.
- If the product of these three factors is greater than
- **R** = Resistance, then change is possible. Because of the multiplication of D, V and F, if any one is absent or low, then the product will be low and therefore not capable of overcoming the resistance.

To ensure a successful change it is necessary to use influence and strategic thinking in order to create vision and identify those crucial, early steps towards it. In addition, the organization must recognize and accept the dissatisfaction that exists by communicating industry trends, leadership ideas, best practices and competitive analysis to identify the necessity for change.

Some documentation also refers to the resistance to change as the cost of change. It is then subdivided into the economic cost of change (monetary cost) and the psychological cost of change. What this tries to demonstrate is that even if the monetary cost of change is low, the change will still not occur should the psychological resistance of employees be at a high level and vice versa. In this case the formula for change is represented as:

$$D \times V \times F > C(e+p)$$

What this allows managers to do is to isolate the actual problem areas of change and develop unique strategies specifically designed to resolve the correct form of resistance.

Applying Kirkpatrick's Model

As stated earlier, it is important to evaluate both reaction and learning in case no change in behavior occurs. Then it can be determined whether the fact that there was no change was the result of an ineffective professional development program or the result of the wrong job climate and a lack of rewards.

It is important for the professional development personnel to know the type of climate that participants will face when they return from the professional development program. It is also important for them to do everything that they can to see to it that the climate is neutral or better. Without knowing this information and assisting the participant in obtaining a suitable environment, there is little or no chance that the program will accomplish the behavior and results objectives. With an inappropriate climate, a majority of the program participants will not even try to use what they have learned. Not only will no change occur, but those who attended the program will be frustrated with their academic superiors, the professional development program itself, or both, for teaching them things that they can't apply.

Results can be defined as the end effect that occurred because the participants attended and participated in the program. The final effects can include increased scholarly activities and research production, improved teaching quality, increased student satisfaction, increased sized classes, reduced turnover, and higher learning and student achievement. It is important to recognize that results like these are the reason for having some professional development programs. Therefore, the final objectives of the professional development program need to be stated in these terms.

Some programs have these in mind on a long-term basis. For example, one major objective of a popular program on student learning styles and diversity in the classroom is to change attitudes of teachers toward minorities and females in their departments. The programs assert that concerned educators want to treat all people fairly and show no discrimination.

Likewise, it is difficult, if not impossible, to measure final results for programs on such topics as leadership, communication, motivation, time management, empowerment, decision making, or managing change. Researchers can state and evaluate desired behaviors, but the final results have to be measured in terms of improved morale or other nonfinancial terms. It is hoped that such things as higher morale or improved quality of work life will result in the tangible results previously described as parts of these programs.

A Checklist of Guidelines for Evaluating Professional Development

From the beginning it should be stressed that good evaluation of professional development does not have to be costly, nor does it demand sophisticated technical skills, although technical assistance can sometimes be helpful. In its simplest terms what it does require is the ability to ask good questions and the basic understanding about how to find valid answers. Good evaluations provide sound, useful, and sufficiently reliable information that can be used to make thoughtful and responsible decisions about the professional development process and its effects.

Following is a list of guidelines designed to help improve the quality of professional development evaluations. In considering these guidelines, researchers will find that they integrate elements of many of the evaluation models historically applied and discussed in the research literature. This is especially true of those of Tyler, (1942) Hammond, (1973) Scriven, (1972) Stufflebeam, (1969, 1971) and Kirkpatrick (1959, 1977, 1978). Guskey, (2000) set out the goal in developing these guidelines to incorporate those elements that are most applicable and most relevant in determining the merit or worth of professional development endeavors. According to Guskey (2000), literature-based guidelines are not rules. If researchers strictly adhere to them it will not guarantee that an evaluation effort will be flawless. It will, however, lead them in a direction toward making the evaluation more meaningful, more useful, and far more effective.

The checklist of guidelines for evaluating professional development is as follows:

- Clarify the intended goals by assessing the value of the goals.
- Analyze the context by estimating the program's potential to meet the goals.
- Determine how the goals can be assessed.
- Outline strategies for gathering evidence.
- Gather and analyze evidence of participants' reactions.
- Gather and analyze evidence of organization support and change.
- Gather and analyze evidence of participants' use of new knowledge and skills
- Gather and analyze evidence of student learning outcomes.
- Prepare and present evaluation reports.

Summary

This literature review places the context for the study as the setting of the community college system in general. The researcher presented a brief discussion of the historical need for faculty development in the community college and demographic information from studies of the community college system. The NSES revisited the need for professional development during the late 19^{th} century while the characteristics of good professional development were treated in the presentation as well. A detailed and specific focus on the workshops, institutes, courses and seminar area of professional development was included. Some thoughts on teacher change and the promotion of change in both individual teacher's behavior and attitudes and a greater teaching community were also addressed. After an examination of the PEPTYC NSF grant proposals, a comparison of how PEPTYC aligned with the characteristics of good professional development was made. This narration was spread throughout the literature review chapter with insights provided by PEPTYC co-principal investigator Dr. Robert Beck Clark, professor emeritus, Texas A&M University.

Having established this groundwork, the researcher discussed specific processes essential for evaluation of professional development. The main framework for the evaluation process is the Kirkpatrick model framework for evaluation of business training (Kirkpatrick, 1978). It is seldom used in education evaluation, but it appears to be an excellent fit for the methodology to be used for the rest of this research. Finally, a criteria or checklist for evaluation of any large scale project like PEPTYC is discussed and places the methodological process that will be undertaken by the researcher in this proposed study in context. In the next chapter, Chapter 3, the researcher will present the methodological components of the study.

CHAPTER 3: METHODOLOGY

In this chapter, the researcher describes the methodology that will be utilized in this study. Specific components to be detailed include: the research setting, research design, participants, role of the researcher, data collection procedures, formatting data for analysis, data analysis, trustworthiness of results, and a summary.

Purpose and Research Questions

Stated earlier and repeated here, the researcher's purpose is to examine the effects of the professional development program known as PEPTYC. This investigation is guided by two research questions:

1. In what ways did PEPTYC affect or change the teachers who participated in the program?
2. What were the effective and ineffective practices of PEPTYC that lead to these changes in the teachers who participated in the program?

Research Setting

The study was conducted in the natural setting of each subject's life. All interviews were done at a college location in front of the subject's computer, in a classroom, or at his/her chosen professional career base. The interviews were done in person, on the phone, via e-mail, or at a professional society meeting of physics teachers. Most of the internal and external post project evaluation survey data were recorded during the seven May Institutes held at Texas A&M University by the program leaders and the project's external evaluator. This initial program evaluation data was examined for background and stage setting. These data were evaluated to assist in the development of interview questions for both the participants and the programs instructional presenters. This data is one of the three core sources of data the researcher had available to paint the broad picture of the professional development program known as PEPTYC. The three data sources include previously gathered evaluation materials, e-mail survey responses, and in-depth interviews of participants and instructional leadership. The previously gathered evaluations provided material to strengthen the interviews and survey data that was collected and targeted in this research process.

Research Design

This investigation was designed as an exploratory case study. A case, as defined by Patton (Patton, M. Q., 1990), is a unit that includes, but is not limited to, a person, program, event, community, or time period. As suggested by Creswell, a case is a system bounded by "time and place" (Cresswell, 1998). Patton further states that, "Case studies are particularly valuable when the evaluation aims to capture individual differences or unique variations from one program setting to another or from one program experience to another" (Patton, M. Q., 1990). In a naturalistic case study an investigator attempts to present a holistic depiction of the context, detail, and depth of the case. Beliefs rather than facts form the basis of perception in naturalistic research. Lincoln and Guba stated that:

> "Qualitative research assumes that there are multiple realities—that the world is not an objective thing out there, but a function of personal interaction and perception. Qualitative research is a highly subjective phenomenon in need of interpreting rather than measuring" (Lincoln & Guba, 1985, p.17).

Naturalistic methodology is "exploratory, inductive, and emphasizes process rather than ends" (Lincoln & Guba, 1985, p.17). Variables are not manipulated and treatment is not administered. No attempt is made to alter the setting when observation occurs in a natural setting. In this research study, the impact of the PEPTYC Program and its treatments were documented primarily through open-ended participant interviews and case by case comparisons. Additionally, examination of documentation created by participants and the instructional staff were also examined. Care was taken by the researcher to observe the process and not alter the process in any form.

The Case Study Methodology

The case study methodology (Stake, 1995) is well established in the qualitative research tradition. As a methodology, it is especially responsive to research questions of why and how, and it offers scholars a flexible yet integrated framework for holistic examination of a phenomenon in its natural state. It is widely believed that case studies are useful in the study of human affairs because they are down-to-earth and attention holding. They are not however, always a suitable basis for generalization. As the researcher for this paper, I claim that using the case studies approach as the preferred method of research, the target audience is epistemologically in harmony with the intended reader's experience and thus provides a natural basis for generalization to that person. It is most skillfully conducted by researchers who can tolerate ambiguity and are willing to be responsive to emerging data, refining the design of the study even as it is underway.

A researcher expects an inquiry to be carried out so that certain audiences will benefit, not just to swell the archives, but to help the targeted persons toward further understandings. If the readers of this research are the persons who populate our houses, schools, governments, and industries; and if we are to help them understand social problems and social programs, we must perceive and communicate (see Bohm, 1974; Schön, 1977) in a way that accommodates their present understandings. Those people have arrived at their understandings mostly through direct and vicarious experience. The population of teachers who participated in the PEPTYC Project is a unique and specific group whose experiences are isolated within these cases. The generalizations taken too far beyond the doors of this program need to be taken with caution and the understanding that such experiences are still unique. The case study method can accommodate different epistemologies and has application to a wide range of disciplines, especially in the social and behavioral sciences. The design of a case study can be customized to address a wide range of research questions and types of cases and to incorporate a variety of data collection, analysis, and reporting techniques.

The object (target) of a social science inquiry is seldom an individual person or enterprise. Unfortunately, it is such single objects that are usually thought of as "cases." A case is often thought of as a constituent member of a target population. And since single members poorly represent whole populations, the case study is seen to be a poor basis for generalization. Often, however, the situation is one in which there is need for generalization about that particular case or generalization to a similar case rather than generalization to a population of cases. This is the philosophy behind this study. Selectively drawing a sample of cases from a population of approximately 100 participants assisted the researcher in meeting the demands for typicality and representativeness. Hence the results are yielding to the needs for assurance that the target case is properly described. Because case study is exceptionally useful for exploratory research, theory generation, and examination of atypical phenomena, it is particularly appropriate for applied research related to contemporary issues of people in the real world. As readers recognize essential similarities to cases of interest to them, they establish the basis for any naturalistic generalization. Case studies such as this one can be used to test hypotheses. They can examine a single exception or group of exceptions and show that the hypothesis is false. A case study can be highly statistical such as institutional research case studies often are. But in much of the social science literature, case studies feature: descriptions that are complex, holistic, and involving a myriad of not highly isolated variables; data that are likely to be gathered at least partly by personalistic observation; and a writing style that is informal, perhaps narrative, possibly with verbatim quotation, illustration, and even allusion and metaphor. Comparisons are implicit rather than explicit. Themes and hypotheses may be important, but they remain subordinate to the understanding of the case.

Case study research can however, also be used to test hypotheses and modify existing theory, a purpose most closely associated with the positivist orientation. There appears to be a growing trend away from considering case study exclusively and reflexively in a qualitative context to a more expansive view of case study as an adaptive research structure which can accommodate qualitative and quantitative perspectives, techniques, and standards.

A Teaching Paradigm Revolution

"Science is for *all* Americans" and "Science should be something students do, not something that is done to them"--these two slogans epitomize the two revolutions now taking place in American pre-college science education. The first is a revolution in the goals of science education; the second, a revolution in the methods (Lopez & Schultz, 2001). The scientific community has played key roles in both revolutions especially through efforts of the American Association for the Advancement of Science (AAAS), the National Academy of Sciences (NAS), and the National Science Foundation (NSF). Even the American Physical Society (APS), which traditionally has focused most of its concerns about education on the university, has been playing an active role in promoting systemic reform of science education in grades K-8. To understand what this means, the researcher first defined the term paradigm. A paradigm is a world view, a general perspective, a why of breaking down the complexity of the real world. As such, paradigms are deeply embedded in the socialization of adherents and practitioners: paradigms tell them what is important, legitimate, and reasonable. Paradigms are also normative, telling the practitioner what to do without the necessity of long existential or epistemological consideration. But it is this aspect of paradigms that constitutes both their strength and their weakness—their strength in that it makes action possible, their weakness in that the very reason for action is hidden in the unquestioned assumptions of the paradigm (Patton, 1978, p.203). The investigation being undertaken by this researcher was one that was stepping outside the paradigm which the PEPTYC program was initially evaluated under. Kuhn (1970) stated that "Scientific revolutions are tradition-shattering complements to the tradition-bound activity of normal science. They produce a shift in the problems available for scientific scrutiny." This study examined the traditional evaluation practice for professional development programs by expanding beyond the normal, post conference reactionary surveys. The researcher made an effort to understand the effectiveness of the dissemination of curricular material as well as the adoption or reinvention of new materials by the participants in this program. Determination of these outcomes were essential for the researcher to help judge the effectiveness of such a professional development program

Conventional Investigations vs. Naturalistic Investigations

For years social science was limited by its dominant mode of investigation using conventional methodological ideas. Conventional research in social contexts has been patterned after the methods used in the physical sciences; but the physical sciences are very different in important ways. The researcher has a degree in the physical sciences and hence had previously been trained to examine problems in a conventional research methodology. Conventional research makes every attempt to separate the inquirer from the object of inquiry so that the research will not be contaminated. In their book, Naturalistic Inquiry, Lincoln and Guba (1985) proposed an alternative paradigm—a "naturalistic" rather than a "rationalistic" method of inquiry, in which the investigator avoids manipulating research outcomes a priori. This paradigm shift helps the researcher in this project, unfold the design, establish "trustworthiness", and collect and write a case report from the data that was collected. For a naturalistic researcher, the ability to get inside the social context, to share constructed realities with the stakeholders in that context, and to construct new realities that enhance both the knowledge of the researcher and the knowledge and efficacy of the stakeholders is the essence of the research.

As defined by Lincoln and Guba, (1985) a problem is a state of affairs that (1) begs for additional understanding, (2) identifies the need for choosing between alternative courses of actions, or (3) leads to undesirable consequences. "The purpose of a research inquiry is to 'resolve' the problem in the sense of accumulating sufficient knowledge to lead to understanding or explanation, a kind of dialectical process that plays off the thetical and antithetical propositions that form the problem into some kind of synthesis" (Lincoln & Guba, 1985, p. 226-227).

As a naturalistic inquirer, the researcher will operate under a different set of assumptions concerning the nature of reality, epistemology, and generalizability. The aim of naturalistic inquiry is not to develop a body of knowledge in the form of generalizations that are statements free from time or context. The aim is to develop shared constructions that illuminate a particular context and provide working hypotheses for the investigation of others. The purpose, then, for a naturalistic researcher conducting a study similar to a previous one is not to yield the same results, disclose errors in the former methodology, or to strengthen the generalizability to the universe. Rather, it is primarily to expand on the processes and constructed realities of one study to seek initial illumination of the context of another study (Erlandson, Harris, Skipper, & Allen, 1993).

Naturalistic inquiry is always carried out, logically enough, in a natural setting, since context is so heavily implicated in meaning. Such a contextual inquiry demands a human instrument, one fully adaptive to the indeterminate situation that will be encountered. The human instrument builds upon his or her tacit knowledge, as much as if not more than, upon propositional knowledge, and uses methods that are appropriate to humanly implemented inquiry: interviews, observations, document analysis, unobtrusive clues, and the like. Once in the field, the inquiry takes the form of successive iterations of four elements: purposive sampling, inductive analysis of the data obtained from the sample, development of grounded theory based on the inductive analysis, and projection of next steps in a constantly emergent design fulfilled to the extent possible in view of time and resource constraints (Lincoln and Guba, 1985: p. 185-187).

Qualitative Research

Qualitative research is a situated activity that locates the observer in the world. It consists of a set of interpretive, material practices that make the world visible. These practices transform the world. They turn the world into a series of representations, including field notes, interviews, conversations, photographs, recordings, and memos to the self. The researcher in this study examined previously recorded data such as end of institute surveys, projects produced by participants, and scholarly activities done at local and regional meetings. He also examined the in-depth interviews and e-mail surveys that were later conducted making constant comparisons of the data looking for themes within this additional data. Qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or to interpret, phenomena in terms of the meanings people bring to them.

Qualitative research involves the studied use and collection of a variety of empirical materials, such as case study; personal experience; introspection; life story; interview; artifacts; cultural texts and productions; observational, historical, interactional, and visual texts, that describe routine and problematic moments and meanings in individuals' lives (Denzin & Lincoln, 2000).

Emergent Design

The PEPTYC program was a dynamic program, one that changed some of its specific contextual goals while maintaining an overall purpose of dissemination of good physics instructional practices. It is a program that changed purposefully and one that continued to develop over time. The PEPTYC project, while now officially complete, continues to cause changes beyond any initial reports or project analysis done by the co-founders of the professional development institute. Researching such a program brought to light many outcomes that were overlooked in initial reports about the project. These outcomes are the long term outcomes that couldn't be seen, but only hypothesized as future outcomes. Naturalistic methods can provide a deeper, detailed, thick description in studies of unique professional development programs such as the PEPTYC program.

Naturalistic studies are not fully described in advance and do not necessarily adhere to a research design. This study, while formally having a pathway described in the methodology section, also had some divergence from this specifically lain path. Procedures were negotiated; changes in design occurred as subjects were identified, as the researcher interacted with subjects, as the literature was consulted, and as the data were interpreted (Lincoln & Guba, 1985). Most steps in the study were dependent on the results of previous steps; design changes were made based on preceding actions and information. The researcher scrutinized the process and himself for bias. He sought the advice of informed others, and left an audit trail; which allows "public inspectibility" (Lincoln & Guba, 1985, p.6) by subsequent researchers who seek to track the design as it unfolds. Thus, the final research design ultimately emerged as the study progressed toward closure.

Purposeful Sampling

The goal of purposeful sampling was to include a wide range of information and seek maximum variation in the sample (Lincoln & Guba, 1985). The initial criterion for subjects to be interviewed included all participants in PEPTYC over its fifteen year life. From this group the researcher purposefully selected two participants from each of the seven program cycles (PEPTYC I, II, III, IV, V, Quantum Optics-PEPTYC I, II a.k.a. PEPTYC VI, VII). A program cycle is a two-year commitment that included a two-week learning institute held during the month of May and a set of two extended weekend meetings, one held during the fall semester and one during the spring semester of each school year. PEPTYC V was the only cycle of the program that involved only a one year commitment. Even though it was a one year cycle it was treated as a complete PEPTYC institute. Purposeful sampling was performed to encourage maximum variation in the sample of subjects; however, many of the early program participants were from a single geographical region (Texas) and many have retired from teaching, moved on to administrative positions, or returned to teach as former participants within a later cycle of the program. Given these limitations, the researcher had to continue with caution and make the required adjustments as necessary. When difficulty arose in finding these purposefully selected subjects, the definition of a subject was modified to include any PEPTYC participant who was currently employed at a community college and still actively teaching physics. The tentative interview guide and list of probing questions were not used to the same extent in every case; subjects' experiences, personalities, and time available for the interview affected the type and number of questions specifically asked. The interviews were conducted via telephone, e-mail, or face to face. These differences were triangulated via a secondary method in effort to seek clarification or need for additional data collection. This secondary method was created as the study developed. Although it is detailed in the analysis of the data in Chapter 4 of this work, it basically included an additional re-analysis and evaluation of already processed surveys, extended discussion with teaching colleagues of the studies primary participants at their home schools, and they were examined for change recognition or validation of activities since the PEPTYC Program. Specific descriptions of the participants of the study were again developed as parts of the individual case studies detailed in chapter 4.

The Research Instrument

The researcher is the human instrument of the proposed study. He graduated with a Bachelors of Arts degree in physics and mathematics and received his high school teaching credentials in the same disciplines from Hastings College in 1989. He has taught physics at a public high school or in a Community College setting for the past 20 years. His growing interest in research-based issues and a desire for career advancement in academia prompted him to pursue a doctorate in science education at Kansas State University. The researcher has taken graduate courses in experimental, quasi-experimental, and naturalistic research design, quantitative and qualitative methods of data analysis, attended numerous educational symposia and conferences, and read extensively on a range of current topics in the general and professional education fields. He has developed a working understanding of the issues that may be encountered during this study, thus making him qualified and well suited for this role as researcher in a naturalistic research project. The researcher and his graduate committee were aware and wary of any personal bias and over identification with this project. The researcher was an active participant in PEPTYC during cycle IV. His involvement led to his selection by the leadership team as an instructor for the program during its final two stages, Quantum Optics PEPTYC I and II. This additional involvement as an instructor allowed the researcher to form a duel perspective of the activities that were involved in the development of the program from a teacher's and a learner's point of view. Small workshop activities and lectures were prepared by the researcher as part of the program. These lectures and activities were part of the larger instructional package and focused on science education topics such as learning theory and cognitive psychology. The replacement of a previous faculty lecturer/demonstrator was the catalyst for this leadership change. After spending approximately six years directly and indirectly involved in the program, the researcher felt a connection to the program and was excited to undertake a detailed study to bring a scholarly closure to the project.

A danger for any naturalistic inquirer is the possibility of "going native." This point is moot in the study, as the researcher was already considered a "native" and a "pre-factor" participant observer. Lincoln and Guba (1985) warn against "overidentification with the cultural values that characterize a group or a situation being studied" but also state that "either underidentification or overidentification with contextual values lead to errors; the key appears to be that the investigator examines his or her own values as well as the values of the context or situation" (Lincoln & Guba, 1985, p.177). The researcher took this statement very seriously, and he designed the research to comply with that counsel.

The Use of Tacit Knowledge

Like most academic fields, physics education has its own vocabulary, social and professional structure, history, and values—much of which is tacitly understood by its members. The subjects and researcher share this tacit knowledge because of their participation and experiences in the PEPTYC program, teaching physics, and the physics classroom setting. They are able to communicate using the "shorthand" of this knowledge that results from a common educational and professional experience. The researcher's charge is to make this tacit knowledge explicit, so that a non-science teaching reader can understand and benefit from the case study. Knowing the "native language" of a culture or group is essential for proper understanding (Becker & Geer, 1970); part of the researcher's mission is to act as a translator between the world of physics education and the wider world of interested readers.

Use and Protection of Human Subjects and Storage of Data

The study complies with Kansas State University Institutional Review Board (IRB) policy on the use of human subjects. Subjects were asked to sign an informed consent document that indicated their consent to participate in the study. A copy of this consent form is presented in Appendix A. The research was not expected to cause anyone any harm, and subjects could decline to participate before the study began or could withdraw from the study at any time. Confidentiality of subjects was guaranteed; each subject was identified only by a number and in descriptive and general terms. Subjects were allowed to give input or ask questions during any phase of the study; they were debriefed after data collection and at the conclusion of the study. Finally, formal thank you notes and a summary of findings were sent to each subject.

Although the participants' identities can not be fully protected, the researcher did not directly link any form of data to a participant's identity. Direct identification was utilized on interview forms, e-mail correspondence and any other documents used by the researcher for data collection. Identification codes were used as well. However these identity keys are now kept in a location separate from the data; these keys were known only to the researcher, and identities of subjects will never be publicly revealed. The data is being stored for at least three years in a locked and fireproof filing cabinet in the researcher's home.

Data Collection Procedures

There were three primary sources of data that were gathered for this research. Documents were gathered from the principle investigators of the PEPTYC project (Robert Beck Clark and Thomas L. O'kuma). These included the end of the May Institute internal and external evaluations, as well as any existing project outcomes or reports that were turned into the leadership team. This data source contains a number of different sources which will be referred to as pre-existing documentation or data source one. Data source two included, E-mail surveys specifically designed by the researcher for this project and conducted on each of the seven PEPTYC groups. Data source three was in-depth interviews of fourteen specifically selected participants' two each from the seven distinct cycles of the program. These also include a number of instructional presenters who were first participants on the program. All of these interviews were conducted by the researcher. The complete process of these data gathering experiences is documented in the discussion below.

The following procedures were followed in gathering qualitative data for this study:

1. The project leaders independently analyzed survey data from the various cycles of the PEPTYC program. These initial data sources were used for changes in the program and reports to the NSF. These reports were again

analyzed by the researcher to establish a base line of information and to inform the design of the questions for the personal interviews.

2. The researcher also examined the external evaluation reports compiled by Michael Neuschatz and Mark McFarling at the American Institute of Physics (AIP). This external evaluation was done during the last two two-year cycles of the program. The data were used to assess the goals of the PEPTYC project by Robert Beck Clark and Tom O'kuma, and reports were also distributed to the collaborating instructors for the project, including the researcher. He examined this data initially and primarily to improve his overall view of the project and as an assessment of the strengths and weaknesses as perceived by the participants immediately following the two year workshop sequence which he was involved in as an instructor. These were compared to the responses that were made by the participants who were interviewed for this specific study, now years later. They are one of the core comparisons of data for the analysis done in this study.
3. An informal individual interview was done by the researcher with the project founder during the final May institute of the PEPTYC Quantum Optics Program. This interview was transcribed and analyzed to assist in gaining a historical perspective of the PEPTYC program as seen through one of the founding creator's words. Follow up interviews were done with Dr. Clark and Mr. O'kuma to triangulate any additional data and commentary that their reflections of the project have produced since its completion. See Appendix A for the protocol for these interviews.

4. An e-mail survey questionnaire was completed by the researcher to gather demographic information and reaction information towards the PEPTYC project and the research that was being done on the project. In this e-mail questionnaire the participants were asked about their willingness to participate in the phone interview aspect of this project. See Appendix B for the protocol for the e-mail survey.
5. Based on the assessment and analysis of data sources from 1, 2, 3, and 4, as well as additional reading of literature that was completed, a series of interview questions were created and then administered to the 14 purposefully selected participants from the PEPTYC program. Responses to these questions were analyzed, summarized, and compared to the previous data collected by the project evaluators and principle investigators for both triangulation of existing results and discovery of new outcomes. See Appendix C for the protocol for these individual participant phone interviews.
6. Data was checked for the application of new curricular innovations and teaching methods in the classroom since the participation in the PEPTYC program. This was done by looking at current syllabi from the interviewed instructors as well as doing an evaluation of the instructional philosophy reported via the interview process. An analysis of the scholarly activities that participants have undertaken in the broader physics teaching world was done. Determining what the long term effects on their local physics programs were, the impressions of their physics teaching colleagues were, and views of the participants physics instruction was also examined to highlight changes. In

addition the investigator analyzed the data for instructional implementation ideas.

7. If additional information was needed to be gathered or was needed from the participants' colleagues at their various home institutions, then follow up interviews and survey analysis were undertaken.

Triangulation

This is substantially a "post-hoc" study; the marker events of professional growth and development have already occurred. Participant observation of the process is not possible. However, because the experiences of the researcher have paralleled those of at least some of the subjects, he can be regarded as a participant observer of a process that has already transpired. Triangulation of data occurred from the three basic sources. First, active participation of the researcher as a participant and instructor for the PEPTYC program including the reflections and analysis of these experiences will provide a data source. Second, a series of post program evaluations done by the principle investigators of the project and surveys which were created and given by the program founders as well as the research done by the external evaluators, including their documentations, will provide additional data to analyze. E-mail surveys that were returned to the researcher were also included in this data set. Third, the researcher's personal interviews with 14 purposefully selected program participants will provide an independent and up-close-and-personal method for gathering data on participants' view about PEPTYC.

In-Depth Interviewing

In the book *In-Depth Interviewing*, the authors (Minichiello, Aroni, Timewell, & Alexander, 1995) discuss the types of questions that a researcher should ask when doing an in-depth interview. Accordingly, questions need to be related to the type of information which they are supposed to elicit. Descriptive questioning (Spradley, 1979; S. J. Taylor & R. Bogdan, 1984)) leads interviewers to ask informants questions to provide descriptions of events, people, places and/or experiences . This non-threatening strategy allows for the interviewer to probe for experiential information while taking control of how the information is being gathered. This type of questioning was typically done during the structured interviews with the 14 purposefully selected participants.

Several researchers (Burgess, 1984; Spradley, 1979) refer to two other types of questioning often times used in conjunction with the descriptive mode. The first is a structural mode of questioning. The researcher asks questions which tend to look for an organizational structure in the knowledge of the informant. The researcher is trying to determine categories of knowledge which the informant perceives they have been engaged in as well as developing stratification levels for the study. The second form of questioning is contrast questioning. Information received from informants that contrasts or compares situations or events within their own world view and their own meaning can be obtained from this type of questioning.

Patton (1990) asserts that another form of questioning outside of the descriptive mode could be labeled as "opinion/values questions". These questions are aimed at trying to understand the cognitive and interpretive processes that people use or think about with respect to particular subjects, occurrences or situations. In contrast to this mode of "what do you think" or "what is your opinion about it" type of questions, Patton also discusses looking for people's emotional interpretations by soliciting information from "feeling questions". An interviewer might ask "How do you feel about that? Do you feel happy, sad, confident, intimidated, anxious…?" (Patton, M. Q., 1990, p. 207). These types of questions were used during the individual interviews and were asked in a form that elicited responses from "how did you feel before, after, and now that the PEPTYC project is over?"

If a researcher wants to find out what factual information the informant has, they might want to ask "knowledge questions." Patton (1990) attests it is important that if a researcher assumes the informant knows specific things, then determining where the factual information originates from is a key. Sensory questions are another form of questioning. These questions search for information about what was seen, heard, touched as well as what type of stimuli the informant reacted to during the experience. They are sometimes considered a form of descriptive questions like the demographic background questions that are traditionally asked to provide the researcher with usual categorical information for comparison study. These types of questions were used in the e-mail survey and were readily available for analysis by the researcher. Some people argue that it is preferable to ask demographic type questions at the end of the interview or tie them to descriptive questioning at the beginning. Regardless of the time, they provided a great deal of valuable information for analysis. Familiarity with the interviewed participants made these demographic questions somewhat redundant.

Original or primary questions are the types that are used to begin interviews or introduce a new topic. Probing or secondary questions are also applied as a method of clarifying and gaining more detail and meaning to the answers given by informants to primary questions (Stewart & Cash, 1988). During in-depth interviews, efforts to elicit greater detail in information are oftentimes needed, especially when statements are incomplete, vague or not available. The most often used form of probing or secondary questions however is the nudging probe. The nudge is used when informant answers seem incomplete or informants are hesitant to continue. The researcher might try to redirect the informant by repeating the question or making an exchange in the conversation based on a comment made by the informant. The interviewer might also attempt to make a reflecting probe that would entail reflecting the answer back to the informant in order to clarify or verify the informant information. As the researcher in this project, I found that in-depth interviewing really implies the use of original (primary) and probing (secondary) type questioning techniques.

Kirkpatrick Framework Viewed Through an Educational Lens

The Kirkpatrick framework examined from an educational point of view is the lens under which the researcher planned to use to evaluate the PEPTYC project. This framework parallels nicely with the following types of interview questions discussed in the section above. In an effort to understand attitudes of participants, preliminary surveys were taken by the project evaluators. Questions that assess demographics, feelings, opinion/values and sensory experiences were all examined by the researcher. They were triangulated by the survey results which also asked these demographic type and "feel good attitude" questions. These are the questions that address Kirkpatrick's Level I called attitude. Knowledge and descriptive questions were also asked during the interview process. Their analysis assisted the researcher in assessing the informants' view of their learning that took place during the PEPTYC program. This addresses Level II in Kirkpatrick's Model labeled learning. Finally using deeper probing type questions that ask for either a reflection on experiences, a structural scaffolding type assessment of experiences, a comparison and contrasting of ideas and seeking a series of responses to "hypothetical", "devil's advocate" and "posing the idea" type questions assisted the researcher in obtaining data for the transfer (Level III) and educational results (Level IV) aspects of the Kirkpatrick framework. Open ended, in-depth interviewing techniques being used by the researcher probed deeper into the "after the fact" understanding of what type of mindset and philosophical understandings were created by the activities performed and experiences learned during the PEPTYC program.

Grounded Theory

Researchers use grounded theory to develop explanation after the investigation of interaction, behaviors and experiences as well as individual's perceptions and thoughts about them. The main aim of grounded theory is the generation of theory from the data, although existing theories can be modified or extended through this approach. Grounded theory researchers start with an area of interest, collect the data and allow the relevant ideas to develop. The grounded theory style of research uses constant comparison. The researcher compares each section of the data with every other part throughout the study for similarities, differences and connections. Themes and categories are identified in the literature and data are coded and categorized. It is from this analysis process that major concepts and constructs are formed. A search by the researcher to find the storyline for the study is examined through these themes. The approach uses both inductive and deductive processes. Researchers are seeking eventually to establish a hypothesis. Grounded theorists accept their role as interpreter of the data and do not stop at merely reporting them. Development of insight and awareness of relevant and significant ideas show that researchers must have theoretical sensitivity while collecting and analyzing the data. Personal and professional experiences can help make the researchers sensitive to these emerging ideas. Asking further questions and seeing the ideas as provisional help them to be linked back to the data and finally confirmed in its analysis. Using the grounded theory approach was beyond the required extensive data collection, time in the field and multiple sites for the researcher to compare and contrast in this research project. As a novice researcher, the work done on this project contributed toward building a grounded theory, however, none was actually developed from the work; nevertheless it was focused instead on finding patterns and themes to analyze through constant comparisons.

Theoretical sampling was guided by ideas which the researcher sees have significance. Finch & Mason (1990, p. 28) explain "Essentially theoretical sampling means selecting a study population on theoretical rather than say, statistical grounds." Hence, initial sampling decisions were made by the researcher before the project began. Saturation of data was really an impossibility since the number of sampled participants wasn't enough to reach such a level. The gathering of the data was limited by and based upon the number of participants who were purposely chosen, guiding the researcher to his own opinions of sources for further data. Initial interviews or observations guided the researcher with cues from the first emerging ideas and helped him modify the interviews while the data became progressively focused.

Constant comparison is useful for finding the properties and dimensions of categories. This process assists in looking at concepts brought out by mining newly acquired data. Comparing concepts and subcategories, the researcher was able to group them into major categories and label them. Incoming data was checked for their "fit" with existing categories. Credible theory must have explanatory power linkages between categories and specificity. Two types of theory are generally produced: substantive and formal theory. Since the researcher only intended to find patterns, credible theory didn't arise in the data. If theory would have been formed from the study it would be categorized as either credible or substantive theory, emerging from one particular context. Hence, its application is therefore limited. Or secondarily, a formal theory is generated from many different situations and settings. Its application is conceptual and has higher generality. In this study grounded theory wasn't generated, rather the researcher focused instead on pattern and theme analysis through constant comparison. This was tied tightly to the context of the professional development process in the PEPTYC project. Therefore, the analysis in this study yields a substantive "understanding" and not a formal theory. A more specific application of the analysis of data to produce a grounded understanding rather than grounded theory follows in the next section.

Inductive Data Analysis and Grounded Understandings

Chapter four will be devoted to data analysis, but an overview will be presented here. Data analysis will occur simultaneously with data collection and will be guided by Lincoln and Guba's recommendations: "What is at issue is the best means to "make sense" of the data in ways that will, first, facilitate the continuing unfolding of the inquiry, and, second, lead to a maximal understanding of the phenomenon being studied in its context" (Lincoln & Guba, 1985, p.224). The goal of this inductive analysis was to develop appropriate, relevant, trustworthy, interpretations of the data. The researcher developed working hypotheses from, not impose them upon, the raw data. Throughout the data collection period, the researcher scrutinized the transcripts of interviews and any of his additional field notes to identify themes, strands, patterns, and trends occurring within and between the various cases. As the study progressed, tentative relationships were presented to subjects for scrutiny, verification, validation, and modification. Although the researcher's broadest goals to develop grounded theory from the data were not met, the paucity of subjects, exploratory nature of the study, and lack of related work caused him to re-define the goals as the more obtainable development of "grounded understandings." In science, grounded understandings are not developed from the absence of bias, but rather from the recognition and control of bias. The scientific process facilitates a clearer view of what researchers do understand in the context of what they do not understand. According to Glasser and Strauss (1967) grounded scientific understandings are based on knowing what researchers do not know and keeping what they do know in the context of what they do not know, in gathering relevant, valid, and balanced information, in analyzing relationships and influences and in making interpretations and supporting conclusions. With this awareness, a researcher can maximize the chances for obtaining more valid and reliable information, for making grounded interpretations or theories, and, perhaps most important, qualifying their interpretations to acknowledge where they are and are not relevant.

Constant Comparative Method

The constant comparative method was used to construct themes that emerge from the data. The following recommendations from Bogdan and Bilken (1982), Glaser (1978), Taylor and Bogdan (1984), and Stainback and Stainback (1988), guided the data analysis:

1. Data was collected from multiple cases.
2. Data was examined for the presence of recurring topics, common strands, and key statements; categories on which to focus were identified.
3. Incidences of data within the categories of interest were collected and used for elucidation and elaboration of the categories.
4. Categories were described so as to account for incidences. New categories were formed and old categories were deleted as needed.
5. The data within the emerging categories were examined and analyzed; patterns and relationships between the data were sought.
6. The categories were refined, their properties identified, relationships explored, and they were "[integrated]… into a coherent theory" (Stainback & Stainback, 1988, p. 42).

It should be noted that since no prior naturalistic research has been conducted on the PEPTYC project as a model of professional development, the nascent models developed herein will be offered as tentative suggestions of existing relationships. Additional studies may clarify, redefine, and modify these relationships. The hypotheses generated from this study will be called assertions, interpretations, recommendations, and implications, and will be presented in Chapter Five.

Data Collection Sources

Multiple data sources were utilized to generate the data of this case study over the period of about 1 year. Table 2 illustrates the data collection sources. The methods of collecting qualitative data included: Individual interviews with 14 different participants from the PEPTYC Project; an e-mail survey of participants still living or active in teaching at a two year college; Pre-existing documentation which included the following, individual interviews with the Co-Project Investigators, formal internal evaluations from each of the May Institutes; external evaluations from American Institute of Physics; individual project reports of the participants; and any additional related grant reporting documents. These combined procedures offered a more holistic perspective of the issues being explored and several sources of evidence, resulting in increased trustworthiness of the investigation (Lincoln & Guba, 1985; Miles & Huberman, 1994; Yin, 1994).

Data Collection Sources

Table 2 Data Collection Sources

Data Sources (3) with *subsets (5)*	**Frequency of Data Collection**	**Format of Data**
Pre-existing documentation	Duration of PEPTYC project.	Five examples are immediately below
May Institute Final Evaluations	One per year after each May Institute (13 total).	Structured reflective summary forms (quantitative and qualitative)
Related Project Outcome Documents and Reports	As acquired and needed.	Transcribed descriptive and reflective summaries
Co-Project Investigators (leaders) Interviews	One each, after the final May Institute (at least 3 follow up conversations with each leader).	Transcribed audio/video recordings of each interview
AIP External Evaluation	One per year after each Qu-Op May Institute (4 total).	Structured reflective summary forms (quantitative and qualitative)
Researcher Observations	During participant experience and instructor experience.	Personal recollections and notes.
E-mail survey of 7 different sets of PEPTYC participants	One with one follow up for non responders.	Transcription of descriptive and reflective summaries
14 individual interviews of PEPTYC program participants	One each, during a set down meeting (total of 14).	Transcribed audio/video recordings of each interview

Interviews. Interviewing is the established mode of obtaining information in qualitative research. Lincoln and Guba (1985) suggested that the purpose of interviews is to obtain the here-and-now constructions related to person, activities, feelings, events, motivations, and concerns. The researcher was able to conduct a total of 14 individual interviews with each of the selected faculty participants as well as individual interviews with the two project co-directors. All interviews were taped and transcribed. These interviews allowed the faculty member the opportunity to verbalize in-depth reflections regarding the PEPTYC Program, it processes, structure, and the events that lead to participation and their view of the effects it had upon them. Questions asked in the interviews were related to the description of the program, its contents, and the impact of the meetings upon each of them. The same open-ended questions were repeatedly asked to all of the members during each interview.

Documents. Documents provide a "ready-made source of data" and allowed the researcher easy access (Merriam, 1998, p.112). Contextual and historical dimensions were added to data collection (observation reflections and interviews) through documentation. Written documentation enriches what is seen and heard; supporting, challenging, and expanding the researchers' "portrayals and perceptions" (Glesne & Peshkin, 1992, p 54).

Glesne and Peshkin advise, "Documents corroborate your observations and interviews and thus make your findings more trustworthy." (1992, p. 52). Furthermore, written documentation may raise new questions and redirect observations and interviews. The researcher gathered and examined a range of documents to include materials such as course syllabi, project reports, curriculum packages, and laboratory manuals.

Formatting Data for Analysis

Before engaging in data analysis, the researcher organized the data into a format conducive for analysis by utilizing the following procedure.

1. ***Transcription of Data***. The interviews were transcribed verbatim in a style similar to a court reported transcript. They were done on a word processer with each interview file initially done separately later to be melded into a package with groups of answers from each source under each specific question.

2. ***Transformation of the Transcripts***. The transcripts from all interviews and observations were transformed to protect participant identity by using the following four step process:

1. The first step was to edit the transcripts for typographical errors, as well as any spelling mistakes. Grammatical errors were not addressed since this transcription was recorded verbatim from the tapes.

2. The second step was to code all interview participants' names, thereby protecting identity. The interview participants were named: JM11L, JM12O, MF21M, …MF71W (See Table 9). While the co-project leaders were identifiable as Dr. Robert Beck Clark and Thomas L. Okuma, the approval of their identification was given to the researcher when the project was started and hence the lack of their anonymity really was not essential.

3. The names of any persons, places, or things resulting in the transcribed data that would indicate identity were assigned a code as well.

4. Finally, the questions and answers were numbered, not sequentially, but in accordance with the question that followed the interview protocol. The researcher then began the process of "coding" the transcribed and identity-protected documents.

Data Analysis

Data analysis was undertaken by the researcher for the express purpose of understanding the data and being able to present that information to others (Bogdan & Biklin, 1998), Stake (1995, p. 78) explained that analysis of data in a case study is conducted with a sense of correspondence described as a "consistency within certain conditions" "practiced in the search for patterns" utilized in the search for meaning." Stake further advised:

> "We are trying to understand behavior, issues, and contests with regard to our particular case… We try to find the pattern or the significance through direct interpretation, just asking ourselves "What did that mean?" For more important episodes or passages of text, we must take more time, looking them over again and again, reflecting, triangulating, and being skeptical about first impressions and simple meanings (Stake, 1995, p.78).

Data collection and data analysis are integrated into qualitative study and are identified as reciprocal activities that Lincoln and Guba (1985) suggested result in the ongoing process of data analysis.

Data analysis procedures of the study involved three operations: unitization, categorizing, and case study construction (Lincoln & Guba, 1985). To facilitate this process, the researcher isolated himself for long periods of uninterrupted time to become more fully immersed in the meaning of the data and to develop a clear focus. Transcripts from all interviews and all observations were analyzed one at a time until all were completed. The researcher made three basic sweeps of data to begin coding data. First, each transcript was read in its entirety to gain an overview assessment. In the second sweep of the transcribed document, the researcher reviewed the transcripts line by line within each paragraph (Strauss, 1987) and began make notes, or "marginal remarks" on the transcript (Miles & Huberman, 1994). During the third sweep, the investigator began to unitize the data by circling, underlining, and highlighting any units of data that emerged as having significant meaning (e.g. paragraphs, sentences, or segments of sentences) or indicated emerging word themes and patterns.

Unitizing

Unitizing requires the researcher to analyze the accumulated observation, interview, and document data for any small piece of meaningful data; a unit of data relevant to the focus of the study that causes the analyst to think beyond the information contained in the unit. A unit of information was described by Lincoln and Guba (1985, p 345) to be: "the smallest piece of information about something that can stand by itself—that is, it must be interpretable in the absence of any additional information other than a broad understanding of the context in which the inquiry is carried out." These units of data (word, sentences, and paragraphs) were then assigned codes.

Coding Data

Breaking down transcribed or synthesized data to meaningful information while the relationships between the parts remain intact requires coding and coding is data analysis. Coding data can be a straightforward process, but it can be tedious work scanning methodically, sorting data segments, and assigning categorical labels. Codes are labels that describe and assign meaning to units of data. They are used to organize and retrieve various chunks of data. Codes occur throughout the analysis. Most importantly, codes pull together large amounts of data necessary for analysis (Miles & Huberman, 1994).

The research investigator developed a list of codes identified with a concept closest to the description. A code list can have up to 50- 60 codes that can be retained in the analyst's short-term memory without continuous reference provided there is clear structure and rationale (Miles & Huberman, 1994). During the analysis of this case study, 45 codes were defined. These codes changed as data were refined. Table 3 illustrates the coding list.

Table 3 Coding List

Coding List

C- Collaboration

Peer-Peer Instructional Role Model………………………….	C- PPI
Professor Instructional Role Model………………………. …	C- PI
Small Group Projects ………………………………..........	C- SG
Friends and Colleagues ………………………………………	C- FC
Working Climate ……………………………………………..	C-WC

CE- Curriculum Experiences

Active Learning Methods…………………………………….	CE-AL
Interactive Lecture Materials…………………………………	CE-ILec
Interactive Laboratory Activities…………………………….	CE-ILab
Design (Creation) of "New Materials/Adaptations"…………….	CD-Des
Reflective Time………………………………………………...	CD-RT

PE- Pedagogical Approaches

TI- Traditional Instruction ……………………………………	PE-TI
Lecture Style…………………………………………	PE-TI-LS
Demonstration………………………………………..	PE-TI-Dem
Problem Sets…………………………………………	PE-TI-PS
Talk to Students……………………………………….	PE-TI-T
RE-Reform Efforts…………………………………………….	PE-RE
Projects………………………………………………..	PE-RE-P
Listen to Students………………………………….….....	PE-RE-L
CA- Computer Assisted……………………………………….	PE-CA
Web Activities…………………………………………	PE-CA-W
MBL Driven…………………………………………..	PE-CA-MBL
SA- Scholarly Activities ………………………………………	PE-SA
Give Presentations (Talks)……………………………	PE-SA-P
Attend Meetings ……………………………………..	PE-SA-A
SV-Student Views ……………………………………………	PE-SV
Attendance …………………………………………..	PE-SV
Transfer Success……………………………………..	PE-SV
Attitudes for Course…………………………………..	PE-SV

Category Construction

"Category construction is data analysis….(Merriam, 1998, p.180). The processes of unitizing and categorizing provided the progressive focus of this study. Organizing and re-organizing units of information into categories was the essential task of the researcher during category construction.

Merriam (1998) detailed how to determine category efficacy derived by utilizing the following methods:

1. Categories should mirror the goal of the research and provide answers to the research questions.
2. Categories should be exhaustive in practice by placing all relevant data into a category or subcategory.
3. Categories are required to be mutually exclusive with a singular fit of unit to category.
4. Categories should be sensitizing; care in naming the data should allow readers to gain a sense of the category.
5. Categories should apply equal levels of abstraction to all categories and be conceptually congruent.

This process allowed the researcher to merge coded data together, thus contributing a more precise analysis of the data.

Case Study Construction

Ultimately the aim of this study was to develop a synthesized case study report that documented the impact of the PEPTYC professional development model on a group of two year college faculty who engaged in the teaching of physics at two year colleges. Categories and themes emerged as the researcher engaged in ongoing analysis throughout the study (Miles & Huberman, 1994). These categories and resulting themes were used in chapter four to construct the case study report.

Limitations of the Methodology

Some of the strengths of a naturalistic study can also be sources of weakness. Humans are fallible instruments and subjects, and humans were involved in this study. Although the researcher/instrument was alert for areas of bias, over-identification with subjects, or other untoward influences, instances of such might have occurred. The effects of personal interaction with each subject were variable, and could influence the findings. The survey and interview data was collected by only one method, the researcher. The other data was collected by various members of the leadership team. Other studies have been cited to offer support for the sole use of interviews for data collection, but triangulation by multiple methods, not just multiple sources, aids in and producing additional findings. Of the three data sources available for this study, previous documentation, survey data and the in-depth interviews, the interviews depended on self-reports from and interactions with teaching colleagues, who might be viewed as "friends" to the researcher but are only just brief acquaintances, where the potential for bias and distortion is clear. This was the greatest challenge for the study since a collection of artifacts to evaluate level three and four of Kirkpatrick's model only came from the interview data source. There were only a limited number of participants and they were asked to remember what they had done and thought before, during and after their involvement in the project. For some of these interviewees this was a very long time ago. The greatest limitation of the methodology was the identification of the participating subjects. This study spanned a time period of 15 years and a program that changed dynamically as it progressed through each of its cycles. Participants who initially participated in the program were on the cutting edge of specific physics education innovations while later participants were introduced to different innovations. These variations made the selection of participants a key to the success of this research. Finally, the relative homogeneity of the subject group could have resulted in an insufficient range and depth of data. This will be discussed in more detail in Chapter Five.

Trustworthiness of Study

Some scholars suggest that naturalistic researchers should not borrow terms from the conventional paradigm to describe how a study's trustworthiness was established. From the researchers examination of a representation of Lincoln and Guba's (1985) schematic comparison of steps to promote trustworthiness in both paradigms (Naturalistic and Conventional) it is shown that the concepts underlying these trustworthiness issues are shared between the two paradigms. With regards to validity, Stainback and Stainback (1988) stated that a study is valid if there is correspondence between what is studied and what the researcher intended to study. This concept was applied during data collection and analysis, and revisions were made as needed to promote validity. The following steps were taken to increase the likelihood of credible results: triangulation via the use of multiple interview respondents; corresponding colleague checks, survey comparisons, and finally, negotiated member checks with the project directors themselves.

Summary

This chapter described the proposed methodology for this research study. The setting of the study was defined and a review of the purpose, statement of the problem, and the research questions to guide the study were presented. The research design was introduced and data collection procedures were detailed to include; interviews, external evaluation documents, and e-mail survey results. These data were used by the researcher to determine the impact of PEPTYC on a purposefully selected group of participants. An overview of data analysis was presented, and the methodological trustworthiness was described in the concluding section of this chapter.

CHAPTER 4: DATA AND ANALYSIS

The Case Study Methodology

The case study methodology is well established in the qualitative research tradition. As a methodology, it is especially responsive to research questions of why and how, and it offers scholars a flexible yet integrated framework for holistic examination of a phenomenon in its natural state. It is widely believed that case studies are useful in the study of human affairs because they are down-to-earth and attention holding. They are not, however, always a suitable basis for generalization. As the researcher for this paper, I claim the use of the case studies approach as the preferred method of research. I feel that the target audience is in tune with the underpinnings within the two year college instructional environment and thus, to that person, the research product provides a natural basis for generalization.

Research Design

This investigation was designed as an exploratory case study. A case, as defined by Patton (Patton, M. Q., 1990), is a unit that includes, but is not limited to, a person, program, event, community, or time period. As suggested by Cresswell (1998), a case is a system bounded by "time and place". Patton further states that, "Case studies are particularly valuable when the evaluation aims to capture individual differences or unique variations from one program setting to another or from one program experience to another" (Patton, M. Q., 1990, p.54). In a naturalistic case study an investigator attempts to present a holistic depiction of the context, detail, and depth of the case. Beliefs rather than facts form the basis of perception in naturalistic research. Lincoln and Guba (1985) stated that: “Qualitative research assumes that there are multiple realities—that the world is not an objective thing out there, but a function of personal interaction and perception.” Additionally they note, “Qualitative research is a highly subjective phenomenon in need of interpreting rather than measuring” (Lincoln & Guba, 1985, p.17).

Naturalistic methodology is “exploratory, inductive, and emphasizes process rather than ends” (Lincoln & Guba, 1985, p.17). Variables are not manipulated and treatment is not administered. No attempt is made to alter the setting when observation occurs in a natural setting. In this research study, the impact of the PEPTYC Program and its treatments were documented primarily through open-ended participant and staff interviews, and an e-mail survey of participants and case by case comparisons. Additionally, examination of documentation created by participants and the instructional staff were also examined. Care was taken by the researcher to observe the process and not alter the process in any form. Analysis of data included the formation of patterns and themes from the data in an effort to find “grounded understandings” as a result of this analysis.

Contextual Background

PEPTYC: Physics Enhancement Project for Two Year College Physics Teachers

The PEPTYC project covered a fifteen year time frame and actually incorporated seven different cycles within the whole project. It concluded early in the 21st century after a successful run of providing professional development opportunities for nearly 100 different two year college physics teachers. The program was developed by Dr. Robert Beck Clark, Texas A&M University and Thomas L. O’kuma, Lee College, after conversations with colleagues from across the state of Texas and at various American

Association of Physics Teachers (AAPT) meetings. Clark had been running similar programs at Texas A&M for a number of years and with the help of his two-year College neighbor Tom O'kuma, a new program was developed with the two-year College specifically in mind. This program, which the founders and the researcher have collectively grouped and named PEPTYC, included the seven specific groups of individuals who attended the two year project which included two May Institutes and two follow up sessions each year during the duration of their various grants. This was a total of 6 professional development experiences covering a two year time period. These occurred over the fifteen year time frame and will be described throughout this chapter. Sometimes noted via different titles such as the Texas Regional Faculty Enhancement Program for Physics Faculty Members (a.k.a. PEPTYC I) or the Two-Year College Quantum Optics Advanced Technological Education Program (a.k.a. PEPTYC VI-VII) the various reproductions of the basic program always had a group of strongly similar characteristics.

PEPTYC: Funding for the Projects

As can be seen in the following Table 4, the PEPTYC Project was funded by a number of NSF grants. In total, the funding for the project was at a minimum 1.75 million dollars, just in NSF grant money alone. This didn't include the monies that were committed to the project by the participant's home institutions or themselves. These commitments included airfare or other transportation costs to Texas A&M University, or various other locations in Texas, usually three times a year. During the final two programs, the grant asked for the participants' home institutions to provide funding to "start up" some form of quantum optics projects, which was also a large financial commitment for the participants not included in Table 4 below. One also can see the various grants usually ran for approximately a single two year cycle until the Advanced Technological Education (ATE) program which was granted for two complete cycles of two years. While participants were in Texas, the grant funding provided housing and meal stipends, as well as working stipends for their time spent on the various aspects of the PEPTYC project.

Table 4 Funding for Projects

Funding for the PEPTYC Projects

1. **Texas TYC Physics Enhancement Program**,
   NSF UFE, #USE-9054263, January 15, 1991 - December 31, 1993
   $221,690.
   Supplement Award for Participant "At-Home" Projects $ 30,000.
2. **Texas TYC Physics Enhancement Program**,
   NSF UFE, #USE-9255544, May 1, 1993 - April 30, 1994 $123,091.
3. **TYC Physics Faculty Enhancement Program**,
   NSF UFE, #DUE-9354017, May 1, 1994 - November 30, 1996
   $268,864.
4. **TYC Physics Faculty Enhancement Program,**
   NSF UFE, #DUE-9554671, May 1, 1996 - October 31, 1998
   $279,952.
5. **TYC Physics Faculty Enhancement Program,**
   NSF UFE, #DUE-9752718, May 1, 1998 - October 31, 1999 $ 94,983.
6. **TYC Quantum Optics Advanced Technological Education Program,**
   NSF ATE #DUE-9950006, October 1, 1999- September 30, 2003
   $705,616.

Total Grant Dollars received for PEPTYC Programs
$1,724,160.

<u>PEPTYC: Generalized Events making up the Program</u>

Each May, a two week institute brought approximately 25 instructors to College Station, Texas to participate in 12 intensive days of lecture and laboratory activities. One year's institute was based upon 1st semester physics activities and a modern physics topic. The next year's institute was based upon traditional 2nd semester physics topics as well as an additional modern physics topic or special topics in physics component which was thematically spread over the entire two year cycle. Additionally, participants were expected to return to Texas twice a year, once in the fall and once in the spring to attend special sessions specifically designed to reinforce content knowledge, report on progress and rekindle collegial contact with PEPTYC peers. These meetings corresponded with the semi annual Texas Section of the AAPT meetings. Reports, group discussions and peer presentations highlighted these follow up activities. During this research report, the basic program is described as the PEPTYC project, while drawing specific time lines to distinguish groups across the time frame continuum had no effect on the analysis of the entire program.

PEPTYC: Cycle I-Texas Regional Faculty Enhancement Program

Upon reviewing the initial proposal for the *Texas Regional Faculty Enhancement Program for Physics Faculty Members* (also known as PEPTYC I), a $221,690 grant sponsored by NSF (DUE-9054263) was awarded to Texas A&M and Lee College. The researcher found a faculty development program that was funded for a two-year cycle during January 1, 1991 - December 30, 1993, which appeared to have a great number of parallel characteristics with good professional development (Loucks-Horsley, Hewson, Love, and Stiles, 1998) mentioned previously and summarized again. These characteristics included experiences that were driven by a well-defined image of effective classroom learning and teaching as well as experiences providing opportunities for teachers to build their knowledge and skills. Additionally, the characteristics of these experiences included modeling strategies the teachers would use with their own students. The development experiences of building a learning community with peers also was demonstrated with the links to other organizations or support opportunities where teachers could take on leadership roles. Ultimately, an effective professional development experience models continuous assessment practice (Loucks-Horsley, et.al, 1998). The leadership of the professional development program made improvements to ensure positive impact on teacher effectiveness, student learning, leadership and the teaching school community. The seven variations of PEPTYC, developed by the principle investigators of the project, all attempted to make changes that would parallel these characteristics of a good professional development model. These can be seen in the basic structure of the May Institutes, the follow up experiences; as well as the modifications and "tweaks" that occurred after each of the cycles in the program.

Since accountability is an essential element in the evaluation of professional development programs, like many programs that the NSF sponsored, efforts to evaluate both internally and externally lead the principle investigators to make decisions that affected the future of the program, as well as allowed for future funding possibilities. Blended within the researchers data is information that was acquired as part of the project developer's initial program evaluations and NSF reports. This data laid the foundation for the researcher to understand the mind set of participants immediately following the May Institutes and follow up sessions, supplying a baseline of information to make comparisons to, now after a 15 year time span. The following information describes what activities the PEPTYC program was actually comprised of and attempted to accomplish. The changes found within the seven different years of the program were not structural but usually content oriented. These changes are also being described throughout the data and discussion in this chapter.

PEPTYC: Project Objectives

During the course of the entire project the basic objective for PEPTYC slightly changed. As each successive grant was written, the project had minor shifts in emphasis usually dealing with a content variable such as modern physics to quantum optics or computers in education to physics education research; however, after synthesizing the six grant documents for a set of basic goals, the researcher felt the following three objectives best describe the overall project goals.

One objective of the PEPTYC project was to enrich, update, or create participant's content background in various "modern" physics fields such as particle physics, atomic physics, condensed matter physics, quantum optics and physics education research.

A second objective of the PEPTYC project was to improve TYC faculty in their basic skills with respect to various pedagogical topics such as computer usage in all aspects of physics teaching, effective demonstrations without professional support, innovative laboratory experiments, and improved audio-visual techniques. A part of this second objective was to have organized discussions (cracker barrel sessions) on vital program topics of critical interest to two-year college faculty as well as to enhance articulation with universities, provide remediation, and exposure to curricula, textbooks and laboratory manuals, and to provide professional development at the two-year college setting.

The third objective of the PEPTYC program was to stimulate or enhance the involvement of two-year college physics faculty in the communities in which they reside through various programs such as workshops for colleagues, enrichment of curricula, public presentations, partnerships with industry and/or universities, and physics fairs and tests. This aspect was critical for the successful recruitment of more minority students from the local communities into the science and engineering programs at the two year college level and was a major priority during the first 3 cycles of the PEPTYC project.

PEPTYC: Personnel

The program was under the direction of Robert Beck Clark of Texas A&M University and Thomas L. O'kuma of Lee College. Robert Clark is a Professor of Physics and Associate Dean for Educational and Outreach Programs at Texas A&M University. Thomas O'kuma is the Chairman of the Department of Physics at Lee College and a former President of the American Association of Physics Teachers.

Professor Robert Beck Clark, the co-project director, has been involved with and recognized for his contributions to improving physics education for many years. As an AAPT officer, he worked closely with the Physics Education in Two Year Colleges Committee in developing programs to strengthen physics teaching in the two-year colleges. For his role in Texas physics education he was awarded the Robert N. Little Award "for outstanding contributions to physics higher education in Texas" in 1985. The Association of Former Students of Texas A & M University has recognized him twice for the University and College of Science Faculty Distinguished Achievement Awards in teaching. In 1992 he was a recipient of the AAPT Distinguished Service Award for "outstanding contributions to physics teaching" and was the recipient of the Oersted Medal in 1995.

Tom O'kuma has been a member, for the last twenty-eight years, of a TYC physics department first at San Jacinto College North and now at Lee College. Besides his primary duties of teaching introductory physics courses, he has served during all of that time as the department chairman (not a declared position, typical of most Texas TYC physics faculty). He has developed and implemented instructional packages in his introductory physics courses that have led to sizable increases in enrollment and interest in his classes and in physics.

O'kuma has been very active in the TSAAPT and AAPT. Besides serving as President of TSAAPT, he has established several programs which in the past have led to increased participation by TYC faculty in TSAAPT. He has setup over twenty special sessions on the teaching of introductory physics, additional poster sessions on lecture and laboratory topics, and over two hundred and fifty workshops for the teaching/demonstrating of topics associated with introductory physics. He has given more than a dozen invited papers on introductory physics at national AAPT and section meetings and many invited and contributed papers at TSAAPT meetings. He has served on both state and national committees for improved involvement of TYC physics faculty members in their communities and profession. Additionally, he has done considerable research in the effective means of presenting physics concepts through lecture and laboratory experiments. He is presently the workshop coordinator for the TSAAPT meetings and co-project director of a TYC Workshop project. In 1994 he was honored as the recipient of the Robert N. Little Award "For Outstanding Contributions to Physics in Higher Education in Texas."

In addition to the program directors, numerous TYC instructors were involved in peer teaching for the project over the years. Rather than directly name all of them and present biographical information, the researcher has noted that the TYC faculty members have great diversity in their backgrounds, teaching styles, and the TYCs in which they teach. A sample of presenters can be found later in this document under Table 6, A Sample of Presenters. Each brought a wealth of experience and talents to the project. One of the staff had taught at a large metropolitan TYC with a large number of minority physics students; whereas, three others teach at small, rural TYCs with large minority populations. Additionally, staff instructors have come from different areas in the United States and have worked with numerous other projects (i.e. (ICP21) Introductory College Physics in the 21st Century)(A. Dickinson 2005), Visual Quantum Mechanics (D. Zollman 1995-2000), and Workshop Physics (P. Laws 1991) with some level of significance within the physics education community. Each TYC staff member has earned a reputation as a recognized leading authority in his/her own specialty. Each has also earned a reputation as an excellent physics teacher.

PEPTYC: Project Design

The project was designed around three specific components in which all of the participating two year college faculty members were involved. The first component was a two week May Institute which was held on the campus of Texas A & M University. The second component involved the participation in follow-up workshops held in conjunction with the annual fall and spring meetings of the Texas Section of the

American Association of Physics Teachers (TSAAPT). The third component involves the organization of "at-home" projects and programs by the participants. (See appendix E for details) The PEPTYC project was dynamic. Reporting on each specific cycle would be redundant, however, explaining the transition into the last stages of the project seemed essential for understanding and clarification. This is done in Appendix D.

PEPTYC: Project Leaders Philosophy

During a personal interview with Dr. Robert Beck Clark of Texas A&M, the researcher was able to understand the history, philosophy and the basis for the long term PEPTYC Project. Interviewing Dr. Clark provided much data that was rich in description of the overview of the project. The initial data for the project includes an excerpt from this interview. The raw interview data will be available upon request for a period of 1 year after the project is finished. This data is summarized below.

Theme: Peers Teaching Peers

According to Dr. Robert Beck Clark, as far as PEPTYC goes, this idea of “Peers teaching Peers” had come from the PEP program that worked so well for the high school teachers during multiple summers. For every summer from 1968 until 1985, Clark had at least one program for high school teachers. He provided the classrooms and the teachers shared the teaching load. Tom O’kuma and Lee College could have done the PEPTYC project alone but the advantage of having the university partnership includes the graduate credit, residence halls and other facilities.

The instructional model that was used primarily for the pedagogical approaches in the institutes was the “Peer Teaching Peer” model. Peer instruction really means using good teachers and having them helping other teachers. It is also referred to by Clark as the “AAPT- PTRA” model. PTRA is an acronym for Physics Teaching Resource Agents. Clark was a lead principle investigator for that long term NSF program as well. Clark talked fondly of the “Peer Teaching Peer” model. “This idea if you want to help people to learn how to teach better, the best people to do that are successful teachers in the area, they have better knowledge of the students and better ideas and they are going to present it better” (Clark, 2003).

Historical Justification and Credibility

In an effort to justify his position, Clark discussed the first generation of NSF programs, “The ones like those in the 60's, after sputnik.” Accordingly, the programs were almost all hand-me-down programs where the university people “shared their wisdom” to the people who were the high school teachers, but the idea of "peer teaching" really wasn't heard of much during those early stages. According to Clark (2003),

> “If I get up there and teach, faculty might think, ‘Why would it be a big deal?’ He can do it at an institution where he has all this support help, how do you expect us to do it with the students that we have. And the fact is that what you guys have done has been done very successfully.”

For Clark it seems to be a credibility issue. “When a peer talks about it and says it works for me and it would probably work for you, you are a lot more likely to get implementation.” However Clark believes that if an ivory tower person, like a senior researcher, makes a presentation saying “*I've never done it but you ought to do it this way*.”, then the implementation is “*far less likely*”. One additional yet essential component of the program is graduate credit being offered for the work done by the participants. Clark noted, “The idea of graduate credit is important and maybe there is even a credibility issue since it is being offered by an institution that has a reputation.”

Theme: Teacher Change is Evolutionary

When talking in generalities Clark believed that the reality is “*teaching physicists are going to do their own thing*” no matter how the material is presented or what methodology is shown. For him, adoptions, accommodations, adaptations, and implementations are all a part of a continuum. Nobody is going to pick something up and just adopt it, Clark stated. In changing your teaching ways, “its not in peoples’ nature, so what they are going to do is that they come into this smorgasbord, like the type you guys offer, and they are going to pick and choose, and are going to go back and develop their own program which is a meld of what they already have, and what they have become, because of these things you offer” (Clark, 2003).

> “I don't think you are ever going to reach the point where something has all the final answers. It seems to me that it has come to where you have the dialectic, where things just keep on improving little bits, little bits and eventually you kind of create something in teaching where people evolve. Evolve… and that’s kind of the message you get.” (Clark, 2003)

Clark figured he has learned about his professional development method from what has happened historically, not from reading research. The NSF gave the PEPTYC leadership a hard time about this style of program from the beginning. Clark stated, “The NSF Program Reviewers always asked, what your ‘mode of instruction’ is?” They were trying to determine, what exactly it is? What is the approach? Clark tends to think that it's just not one thing. Clark always had a vision that PEPTYC gave people an opportunity to see a number of different and unique things. Somehow this sounds like chaos, but according to Clark, "there are not many places that have this high of percentage of people who make changes in their teaching as a result".

Professional Development: A Final Solution?

Many professional development programs for physics teachers have been developed by physics education research groups which tend to claim,

> "We now have found the solution. Current practice is telling instructors to teach in an interactive way and that construction of theories and discoveries occur often, however, the solution isn't necessarily final."
>
> Clark proclaimed,

Clark spoke of the evolution of instruction and in his evolutionary view, how the participants who participated 14 years ago had changed to the participants that were in the final program. According to Clark,

> "The first group of participants had 24 people, 2 or 3 who did active learning in one form or another. It's kind of the other way around now. There were probably only 3 or 4 who weren't doing something that was a little bit active learning based." (Clark, 2003)

Clark recognized himself in some of the participants, "Some people are "latent Neanderthal instructors who are still doing their old stuff, and who are slowly adding things" but according to Clark, "it used to be it was the other way around." So he didn't feel this program was any less valuable today as compared to fifteen years ago. Clark noted, "People pick up ideas, everyday. People at PEPTYC are saying "oh, I got to write that down, I really thought about it and that's a good idea." (Clark, 2003) From his point of view, "It's the shared learning experiences. Change is always good because if you're excited about something maybe you learn more." Clark further replied, "But I think its more, if students are more involved in their learning, you can't help but to learn."

Theme: A Program about 'Making Informed Choices'

As readers of the research presented here, it follows that the basic intention of Dr. Clark and his co-project investigator was to provide a program that gave instructors choices. These choices were shared with the participants via peers and not spoon fed from the top down. While the evidence is both anecdotal and historical, it does paint a clear image of the foundation for the project. A distinct theme from the interview with Dr. Clark is that the PEPTYC philosophy is about teachers teaching teachers, via a peer instruction model. Additionally, finding experts who had a "stake" in the outcome of curriculum dissemination was essential, as long as the peer presenters were providing the participants with the opportunity to see the materials and make educated judgments on change by themselves. Making informed choices about many opportunities that are available to the two-year college physics instructor was a overriding philosophical position of the PEPTYC program.

In the following section the researcher will create a narrative summary of some of the specifics from the PEPTYC program. Starting with the shell of a schedule of activities and finishing with a summary of the findings from the final evaluations and reactions in general to the PEPTYC program. If the reader wants a more detailed, rich description of the May Institute, it can be found in Appendix E of this report.

The May Institute- A Narrative Summary

The May Institute, a two week physics teachers "boot camp" was the primary focus of each of the PEPTYC professional development programs. For example, during PEPTYC I, twenty-four participants were from Texas two-year colleges with twelve of those attending employed at institutions with high minority student populations. The project was designed to include contextual based modern physics workshops on condensed matter physics, elementary particle physics, atomic physics and accelerator physics. Additionally, computers in physics education workshops on building a system, universal laboratory interfaces, activities and laboratories with the sonic ranger, demonstrations with photo gate timers and smart pulleys, using the computer as laboratory support and using the computer as a tutorial aid and microcomputer based laboratories, all tied together to form a technological strengthening experience. Other workshops, lecture presentations and "cracker barrel type" discussions were included to increase the general skill knowledge and practice of good physics teaching.

These activities included workshops on: 1) the repair and maintenance of laboratory and demonstration equipment; 2) innovative ideas for physics lecture demonstrations; 3) the use of media in the physics classroom and laboratory; and 4) the recruitment of minority and female students. Follow-up academic year workshops included building a photo gate timer, optics discovery kits, building a voltage input device, flash photography and computer interfacing, pinhole camera, string and sticky tape experiments, Interactive Physics™, developing quantitative reasoning in physics, intelligent tutoring for physics problem solving and inexpensive physics teaching apparatus. These activities were held in conjunction with the annual Fall and Spring Texas Section of the American Association of Physics Teachers meeting. The follow up activities included reports from each of the participants on how they implemented the materials that they were shown during the previous May Institute. Guest presentations by well-known experts in the fields of physics education research highlighted the pedagogical education reform experience for the participants. The guest presenters in the first cycle of PEPTYC included Arnold Arons, Priscilla Laws, Ron Thornton, Alan van Heuvelen, James Stith, Patrick Cooney, Joe Pizzo, Tom Hudson and Paul Hewitt. This list of "Physics Education Research Who's Who" is not exhaustive. Each of the projects included presenters from the most current physics education research projects that were actively willing to share their knowledge and experience with the PEPTYC project. The ICP 21(A. Dickinson 2003) curriculum effort was a great example of recruiting PEPTYC participants into their project, tying in the mutual experiences of TYC instructors and their TYC expertise into learning experiences and TYC community building. The instructional materials and development stories were shared by these authors as well.

Original 'at-home' projects by participants are summarized and can be found in Appendix E; however, they also included the development of a large number of active engagement exercises both qualitative and quantitative in nature. They included curriculum development, sharing, and field testing projects. At least 70% of the participants noted that they received some additional funding for the creation of these new projects, with at least 30% reporting that these were external funding opportunities. These supplementary homework activities provided opportunities, encouragement, and a climate for the participants to continue the work that they began at the May Institute.

PEPTYC: Participant Characteristics

Thus far in chapter 4 the researcher has provided a qualitative presentation of the PEPTYC professional development program's contextual background as the introduction to the case study. This contextual background was based on the perspective of administration and staff, as well as documentary records. In particular, The May Institute, the focal point of the case study, was described in a summary section, as well as a rich detailed summary located in Appendix E. This effort was made to paint the overall picture of the PEPTYC professional development model. Dr. Clark's philosophy led to three basic themes, "Peers Teaching Peers, Teacher Change is Evolutionary (or part of a continuum of change) and the PEPTYC Professional Development Model is about "Making Informed Choices". The remaining sections will now consider data that includes both qualitative and quantitative descriptions of the participants themselves. It details feelings about the program which occurred during, and years after the completion of the PEPTYC project. The data from these sections grew from the e-mail surveys and participant interviews, as well as the internal and external evaluation reports that were obtained from the Project co-directors.

PEPTYC Program Demographic Comparisons

As with any program that was continually in a state of flux, the examination of the general population of the participants provides interesting data. The people who attended the PEPTYC program initially started as a "core" of Texans but eventually reached all corners of the United States, Hawaii, and Puerto Rico.

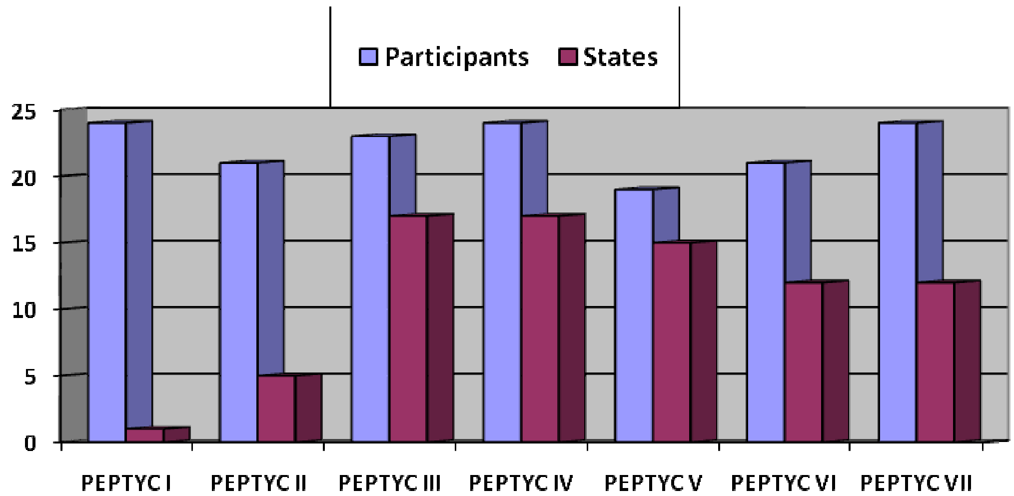


Figure 3 Texas and Beyond

Figure 3 above shows that for the 7 different PEPTYC Programs, the initial participation occurred in one state, (Texas). This expanded over the various programs and eventually reached its broadest audience during PEPTYC III and IV. Minority student populations were no longer a "significant statistic" after the PEPTYC II project and specific targeted participants were no longer recruited. The PEPTYC III-VII cycle looked at an average of this number when used in its individual analysis. Table 5 below shows the participants in terms of numbers, regional distribution, and minority institutes.

PEPTYC Participant Numbers:

Table 5 Participant Numbers

Program	Participants	States	Special Institutes
PEPTYC I	24	(1) Texas	12 minority institutes
PEPTYC II	21	(5) Texas, Border States	15 minority institutes
PEPTYC III	23	(17) Southern States	6 minority institutes
PEPTYC IV	24	(17) Not Regional	3 minority institutes
PEPTYC V	19	(15) Not Regional	3 minority institutes

PEPTYC VI	21	(12) Not Regional	2 minority institutes
PEPTYC VII	24	(12) Not Regional	3 minority institutes

PEPTYC Participant's Comparison to Typical TYC Physics Faculty

Once the program went beyond the Texas regional borders, the attendees were drawn from approximately 11 different states, with 25% from Texas (not surprising, since the conference was held at College Station). In 1996 the American Institute of Physics (AIP) conducted a national survey which was used for general comparisons in this research. While only 20% of the PEPTYC participants were women, this is actually substantially higher than the 11% figure for two-year college physics teachers in general that emerged from AIP's 1996 Nationwide Survey of Two-Year College Physics Faculty. Averages of 10% of the participants in the project were from underrepresented minority groups. Also higher than the 4% figure for the entire two-year college physics teaching population. This wasn't a focus after the second phase of the program, but still was an element of the data. PEPTYC VI-VII program participants had taught a median of ten years at the two-year college level, less than the population median of fifteen years for full-time faculty according to the AIP Survey. This provided the researcher with an interesting insight to examine. Since statistically the average number of years of teaching experience could affect the attitudes and practices these participants brought to the conference, did a more mature audience react differently to the program? The researcher found that during the first two cycles, a more "mature" teaching group participated in the program. The average teaching experience for these two groups was 16 years.

The average experience level (number of years teaching at a two-year college) for the participants in the final four cycles of the program (less than 10 years) was less than the national average (18 years) for teacher experience. However, it was almost greater than this national average during the initial three phases of the program, where the majority of the teachers had greater than 15 years of experience. This transition from more experienced participant groups to less experienced participant groups occurred between cycles II and IV of the program.

When it came to educational background of the PEPTYC III-VII groups, more than 75% of respondents had a physics degree, with all but 5% of those having a master’s in physics. Of those without a physics degree, 5% had a physics minor, and 16% had degrees closely aligned with physics (engineering, chemistry, applied science) with 70% of these individuals also having taken graduate physics courses as part of their preparation. Only 4% of the participants had no physics or related degree, but each of these participants did have significant course work in physics at the undergraduate level. As for highest degree regardless of field, 75% had a master’s, 12% had a PhD and 10% had an EDD.

Participants were clearly focused on physics as their primary assignment, teaching a median of three physics courses during their most recent term. The most common physics courses taught were algebra-based (38%), followed closely by calculus-based (36%), with conceptual physics farther behind (26%).

Participants reported that women made up a third of the physics students in these classes. This number was nearly the same as the national percentage of women in two-year college physics classes found in the AIP 1996 survey. Similarly, participants indicated that their classes were comprised of 19% underrepresented minorities, fairly close to the 15% reported for the national two-year college physics population.

Not surprisingly for a self-selected group of faculty, participants were generally somewhat more "plugged-in" to the professional network than national two-year physics faculty. Of the attending physics teachers, 50% were members of AAPT, while 75% were familiar with the TYC21 networking project. Forty five percent noted that their most common involvement in the TYC 21 program being their reading of the TYC21 newsletter, *Connections.* Forty percent of the participants stated that they had attended a local, regional or national meeting of TYC21. However, only 16% of the attendees stated that they had any involvement with other programs funded by NSF's Advanced Technological Education (ATE). These characteristics seemed to be different than the original two versions of the PEPTYC population. While participants were aware of the two year college physics teaching improvement efforts in Texas, only a small group, approximately 25% of the participants in the first two projects were actively involved in outside instructional activities related to the Physics Education Research reform movement.

PEPTYC Impact of Participant's Concurrent Projects

The TYC 21 project (Palmer, 2000) had a strong impact on the two-year college physics teaching community, but it hadn't started its impact until the third PEPTYC project cycle. The issue of isolation from other physics teachers seemed to have led to a difference in the population of the participants in the later PEPTYC programs. This difference was in both awareness of materials and techniques and an openness to discover what these innovations and changes in the Physics Education Research world were all about. Initially PEPTYC I-V participants' academic focus was primarily on preparing students for higher studies. Thus, when asked what are the primary goals that physics serve at their two-year college, 66% responded that it was preparing students to transfer into four-year science and engineering programs. The need for programs like the PEPTYC QuOP (cycle VI-VII), which placed an emphasis on technical education, not just transfer programs, was seen in the fact that no one answered that providing a basic physics background for students in two-year or other technical programs was a primary goal.

When applying for the PEPTYC QuOP May Institutes, attendees were asked the reasons that they wanted to participate. Nearly 70% wanted to expand or enhance their current programs. Many (65%) also cited professional development and the desire to improve teaching skills. Additionally 45% cited the need to keep their students abreast of cutting edge developments in physics and technology. Others (38%) expressed an interest in the opportunity to interact with other physics teachers. Typical responses from interviews of participants from the original PEPTYC I-II programs included goal statements such as "I had been teaching for a number of years and I just wanted to know what was going on out there." "I needed to meet some other people because I knew that I could do a better job with my students" "I knew that there were good people doing good things, but I really didn't have much time or the opportunity to talk with them". Many of these early participants were extremely isolated from "professional activity" and the influence of an outside organization hadn't really affected them in their classrooms or teaching. Their goals for attending the PEPTYC workshops were more often focused on "Knowledge Enrichment" rather than "Teaching Improvement".

According to the AIP report, the potential usefulness of the workshop in broadening the coverage of two-year college physics programs can be seen in the finding that only 20% of the teachers' home institutions currently offered a course which includes any quantum optics topics at all. Additionally, modern physics is briefly incorporated into the second semester course, but often times it is emphasized in a separate or third semester course which is usually taught at the university level. From the specific data found in the final two PEPTYC programs, only one teacher had ever taught a course devoted to quantum optics, and only two others had ever taught a course that included even a segment on quantum optics.

One reason faculty has not incorporated additional modern physics topics, quantum optics and photonics, into their physics courses is that they themselves may not feel adequately prepared to teach such courses. Most of the participants felt they had low levels of familiarity with some of the modern physics topics, and the quantum optics principles before arriving at the PEPTYC Quantum Optics program. This was not at all surprising to the researcher or the AIP research staff. As with all fast-developing research areas, quantum optics research provided another strong justification to the NSF to provide funding for programs such as this one in cutting-edge sectors of technology.

PEPTYC Participant's Earning Graduate Credit

In each year of the two year programs following PEPTYC I and II, participants had the opportunity to earn 6 graduate credits. Most of the participants planned to use these credits for professional advancement. This was a significant component of the earlier grants. Interviewees with the first cycle participants who returned to a later program said, "You get six credits now, wow, I think we only got three." Another participant said, “I know that after putting in 10 hours a day for 10 days plus the additional 2 trips to the Texas section meetings that I did more work for those graduate hours than I did for the majority of my graduate school course work!” A quarter of respondents said they were going to use the credits toward a degree, split relatively evenly between those seeking masters degrees and those aiming for a doctorate. Regardless of the application of these graduate hours, their significance to the effectiveness of the program was found throughout many comments of participants from each of the seven cycles of the program.

PEPTYC Participant Assessment

Preliminary data from the evaluation of the PEPTYC I program showed a reaction response of participants to the program as being exceptionally positive, with 20/24 giving the program the highest possible ratings on an opinion survey. This trend continued overwhelmingly, according to the May Institute final surveys that were given after each aspect of the program.

Participants’ responses to the question, “I believe that the May Institute was beneficial to me?” are displayed in Table 6. These responses represent all seven PEPTYC cycles. The responses were selected from a Likert Scale with the following categories: Excellent, Very Good, Average and Poor.

Table 6 Participant Assessment

Rating Level %	I	II	III	III	IV	IV	V	VI	VI	VII	VII	Totals
Excellent	91.10	85.70	91.30	86.36	60.87	68.18	73.68	80.95	76.47	65.22	69.57	78.3
Very Good	8.90	14.30	8.70	13.64	30.43	22.73	26.32	19.05	23.53	34.78	30.43	20.2
Average	0.0	0.0	0.0	0.0	4.35	4.55	0.0	0.0	0.0	0.0	0.0	0.8

Poor	0.0	0.0	0.0	0.0	4.35	4.55	0.0	0.0	0.0	0.0	0.0	0.8

The most popular aspects of the program were the opportunities to interact with colleagues from other schools and the hands-on experiences. The lectures by Dr. Michael Duff on elementary particles were also very popular. When the 7 final May Institute Surveys were compared, the main characteristics of successful PEPTYC I experiences were consistently seen throughout the entire 15 year cycle. This specific data is shown later in chapter four.

On the negative side, the least popular aspect of the program was the grueling time schedule of the May Institute. These institutes had the participants scheduled from 8:00 a.m. to 9:00 p.m. each day. Additionally, the survey noted that the atomic physics sessions were perceived as too research or theory oriented, and sometimes hard to follow. This seemed to be the only major complaint about the entire program. The intensive time schedule and commitment that ultimately was required of the individuals who participated definitely established an extra ordinary commitment to improve teaching and gather in new knowledge for these participants.

From the initial, internal evaluation of the participants, located in the Appendix F of this paper, a unanimous feeling of the project participants implied that the program had a tremendous impact on two-year college physics programs in the state of Texas. Future funding and an expansion of the project beyond the boarders of Texas were the visionary hope that the project could serve as a model for future programs for two-year college faculty members throughout the country. This vision was made a reality because of the generous funding that was supplied to the project over its 15 year lifetime. Dissemination of the project findings, participants' work, papers and presentations, have been documented and were analyzed during this research process. Listing the number of papers and workshops presented in tabular form (See Table 8) is part of the documentation that follows later in this chapter. Five funding cycles and fifteen years later, the evaluation of the program continued to have "similar reactions" to the activities and follow-up programs that were created by the PEPTYC I program developers.

However, after the researcher did the individual interviews and surveys of the participants as part of this research, he was able to make a deeper probe into the longer term effects and the behavior changes brought about through participation in the program. This was examined both as an individual case and within the two-year college community in general and led this researcher to continue his probe into a search for more of the subtle effects of the program. As was noted at the beginning of this section, the PEPTYC project was in a constant state of flux, changing over time, but sticking to its foundational structure and philosophy of idea dissemination.

AIP's External Evaluation of PEPTYC

The American Institute of Physics (AIP) was selected by the project leadership to do an external evaluation as part of the PEPTYC VI-II program. This selection was done based upon a recommendation of the National Science Foundation as an outcome of the acceptance of the award for the PEPTYC Qu-OP grant. AIP's evaluation process had three major tasks. The first was to describe the demographic and educational backgrounds of the participants. The second was to ascertain their goals in attending PEPTYC and to look at how well these meshed with the program's designed objectives. The third was to determine whether those goals were met, examining which aspects of the program worked best, and which did not, and making suggestions for future directions. In reality, AIP expanded upon an already strong internal evaluation process that took place during the first 5 cycles of the PEPTYC program. As the researcher was looking through the various sources of internal data comparing them to the AIP data, the only real difference that appeared was the fact that an external assessor did the data recording and reporting. Even through different eyes, the results of the surveys that were recorded by AIP corresponded similarly to the first five evaluations.

Brief descriptions of the data for this first phase of the external evaluation were gathered from three different sources. Initial information was drawn from the program applications which the participants were required to fill out in early spring in order to be considered for the program. Copies of these original applications were not available to the researcher from the previous five internal evaluations, so the comparisons were not made in this category. Additional information was then drawn from two field surveys, a preliminary survey conducted on the first day of the two-week long workshop and a follow-up conducted on the final day. Both of these exploratory questionnaires were designed by the Statistical Research Center of AIP, with additional input from the program director Dr. Robert Beck Clark. This input did parallel the earlier surveys conducted by the program directors and comparisons were made to this data. There were a total of 21 participants in the program when AIP recorded their data. All but one completed the preliminary questionnaire and every participant filled out the application form and the follow-up questionnaire. This was representative of the other five evaluation processes as well. In almost every instant, all the participants in the program provided a general background survey and a post institute survey that were readily available for comparisons. In addition to answering a detailed series of questions, many participants added comments, fleshing out their reactions to various aspects of the program. These reactions are included under various subheadings such as reactions to program structure, program objectives, and program follow up, as well as reactions to “at-home projects”.

Reactions to PEPTYC Program Structure

The AIP evaluation team attempted to examine the effectiveness of the program structure. Attendees were asked a number of questions designed to probe their impressions of the May Institute and its workshops, including the content and level of instruction, the quality of the instructors, and the setting of the institute. According to their survey, the majority of the participants rated all aspects as either excellent or good. Only food and lodging had more than one person who gave a rating as low as fair. This data will be presented in a later section of this research showing a multiple comparison of groups (when applicable). The data from the AIP report showed that the participants' responses to questions regarding the appropriateness of the program's design in general, made evident, the majority of participants stated that the program was suitably structured, although some felt that there could have been more coverage of quantum optics topics and somewhat less of “other” topics. However, participants overwhelmingly concurred that the sessions on quantum optics were pitched at the right level of difficulty for them. The only other complaint was that some found the workshop day a bit too long. When asked which quantum optics sessions worked best for them, more than half of the participants cited the lectures led by Dr. Thomas Walther (a quarter cited these lectures as the most liked aspect of the workshop *overall*.). Typical comments included, “Dr. Walther's lectures were all excellent; his ability to simply explain the complex topics is amazing” and “quantum optics lectures were clear and emphasized the most relevant topics”. Other participants cited the labs as an especially helpful aspect of the program, with comments such as: “I feel I can adapt the numerical aperture lab for use in my classroom” and “the lab went well because we had a chance to see it explained and had some help doing it.” When asked which session on quantum optics worked least well for them, more than half of the participants cited the session involving the process of making single mode fiber connectors. Typical comments were, “The connectorizing sessions were hampered by a lack of single-fiber connectors which prevented me from learning from my mistakes” and “There were not enough sets of instructions and not enough equipment for the size of our group”. Additionally, several participants expressed the view that the session yielded little that would be applicable to their own physics instruction.

During the initial four May Institutes, participants claimed that they really enjoyed the lecture presentations of Dr. Michael Duff. His presentations on M-theory were highlighted in the comments section of the evaluations, with antidotal citations of “Dr. Duff is a charming man, who really made the foundations of the atom come to life for me.” and “I really felt that Duff’s lectures were a highlight for me, I enjoyed hearing about the latest developments in the theoretical physics realm.” Nearly a third of the participants stated this was an enjoyable part of the program for them.

While quantum optics instruction was a major goal of the program, another goal was to provide faculty with experience in new approaches to teaching and different ways to convey the complex concepts that are the basis for quantum optics. Participants were exposed to various new pedagogies, such as Microcomputer-Based Laboratories (MBL), Workshop Physics, Tools for Scientific Thinking, Real Time Physics, Calculator-based

Laboratories (CBL), and Video-Based Labs (VBL). These sessions were designed and led by program staff, who were themselves, two-year college faculty as Clark (2003) described as the Peers Teaching Peers Model. In addition to these instructor-led sessions, there was a scheduled fifty minute sharing session nearly every morning of the Institute. These would consist of about three program participants taking approximately 15 minutes each to share a teaching idea, demonstration, or laboratory idea which they had found to be of value in their physics teaching. When asked, "Which session, other than those on quantum optics, worked best?", the sharing sessions were the most often cited. One teacher summed it up by saying, "The sharing sessions were excellent, as it is always interesting and useful to hear how others solve our common teaching problems." Sharing was so popular that when participants were asked what they liked best about the workshop *overall* it was the number one cited answer. This response was a carry over from the original 5 PETYC programs, (Modern Physics vs Quantum Optics based) and was noted during both individual interviews by the researcher and on the survey results from the project principle investigators as well. In addition to sharing, the sessions on MBL, VBL and Peer Learning all received multiple positive remarks. Typical comments pointed to "MBL lab scenarios, because it helped me become familiar with the new interface" and "Video point presentations were excellent—I can apply this to my lab." When asked which sessions beyond those on quantum optics worked least well, seven participants cited the cracker barrel sessions. These were held approximately every other day of the program, covering topics such as "the role of the two year college physics department in Science, Math, Engineering and Technology (SMET) education" and "let's talk textbooks." Among comments reflecting the general sentiments were: "The cracker barrel sessions didn't always generate new ideas from the group" and "The groups tend to be so redundant that it gets boring when you've heard the same thing four times." In fact, four people cited the cracker barrels as their least-liked part of the program *overall*. From the researcher's perspective, the participants in the quantum optics project tended to have a familiarity with the TYC 21 project, more so than the earlier participants. This quite possibly was leading to some of the negative feelings. As one participant noted "TYC 21 addressed many of the topics from the cracker barrel activities and rehashing these ideas isn't the most productive way to spend time." According to previous surveys done of the initial PEPTYC cycles, "The cracker-barrel provided me a chance to examine issues that are important to two-year college physics teachers today." These instructors' demographic data shows that they hadn't been exposed to the TYC 21 project like the PEPTYC (VI-VII) Qu-Op participant had been.

In contrast to the scattered negative comments, every single respondent said in their internal evaluation survey, that they were glad they participated and that they would recommend the program to other TYC faculty. They also repeated similar statements when individual interviews were completed by the researcher. Other aspects of occasional negative comments included the perceived excessive length of the day, the length of the institute overall the heat and humidity, and the cold showers.

In the AIP evaluation report, the three major reasons that were cited for attending the PEPTYC program included the chance to become familiar and stay current with new technology; the opportunity to learn new instructional techniques; and the chance to interact with other physics teachers from across the country. One person summed it up by saying “Many of [us] could use some new ideas, stimulating interaction and a jump start.”

PEPTYC Internal Evaluation Topic Categorization

In an effort to synthesize data from 7 different cycles of the PEPTYC program, the researcher categorized information that was acquired under 12 specific areas. Within each of these areas a survey question or questions that were given to each participant as either and internal or external May Institute evaluation. A 5 level Likert Scale with the values of Excellent, Very Good, Average, Poor, and Very Poor was designed by the PEPTYC leadership and provided as responses on the questionnaire. This information was collected and analyzed after each of the May Institutes and the cumulative averages from each of the institutes were totaled to produce the information that follows. The researcher has summarized the material by breaking it down into the following categories. Two of the question sets were designed to look at the effectiveness of the topical lectures given by the Texas A&M University faculty experts and the laboratory sessions that were associated with these topical lectures. These lectures included topics of Modern Physics, Solid State Physics, Quantum Physics, and Quantum Optics. Additionally, six question sets were designed to examine the effectiveness of the pedagogical sessions that were conducted by the “peer instructors”, the two-year college leadership and assistants of the program. As Dr. Robert Beck Clark put it,

> “These included the ‘smorgasbord’ of workshop topics such as classroom management styles, computer usage in the physics classroom and laboratory, assessment and evaluation of learning, program and curriculum

innovation and a broad application of the Physics Education Research behind these topics.” (Clark, 2003).

Additional questions addressed the social construction of knowledge in the programs workshops and social interactions such as the cracker barrel discussions, participant sharing sessions, and group lunches and dinners. The final reactionary piece of this evaluation data was the answer to the single question, "I believe that the May Institute met my needs as a two-year college physics faculty member?". Table 7 below summarizes this data and categorizes the questions into these four basic areas. The four basic areas are; topical lectures, laboratory activities, pedagogical topics, and the May Institute met my needs, as previously discussed.

Table 7 Evaluation Topical Areas

1	Topical Lectures (Modern Physics or Quantum Optics).
2	Laboratory Activities (Modern Physics or Quantum Optics).
3	Pedagogical topics (Workshop Physics and Digital Video).
4	Pedagogical topics (Microcomputer Based Laboratories).
5	Pedagogical topics (Assessment and Evaluation).
6	Pedagogical topics (Program Innovations).
7	Pedagogical topics (Curriculum Innovations).
8	Pedagogical topics (Physics Simulations and Web Resources).
9	Pedagogical topics Cracker Barrels (Critical Issues for TYC’s).
10	Pedagogical topics (Sharing Sessions).
11	Pedagogical topics (Group Lunches and Dinners).
12	"I believe that the May Institute met my needs as a two-year college physics faculty member."

<u>Participant Reactions to the May Institutes</u>

Topical Lectures

Each May Institute brought about the opportunity for TYC faculty to interact in a lecture based classroom setting with researchers from Texas A&M University. Dr. Michael Duff and Dr. Thomas Walters were two of the example lecturers that the participants were able to learn from as they presented background materials for the enrichment experience part of the program. Dr. Duff was a theoretical physicist who spoke about the background of modern particle physics that led up to his theoretical additions to M-theory. While Dr. Walters presented the basic course background and information on Quantum Optics as well as assisted in the development of laboratory exercises for the quantum optics lab sessions. These were just two of the examples of the research lectures that were presented. The effectiveness as determined from the post May Institute Survey are shown in the Figure 4 below.

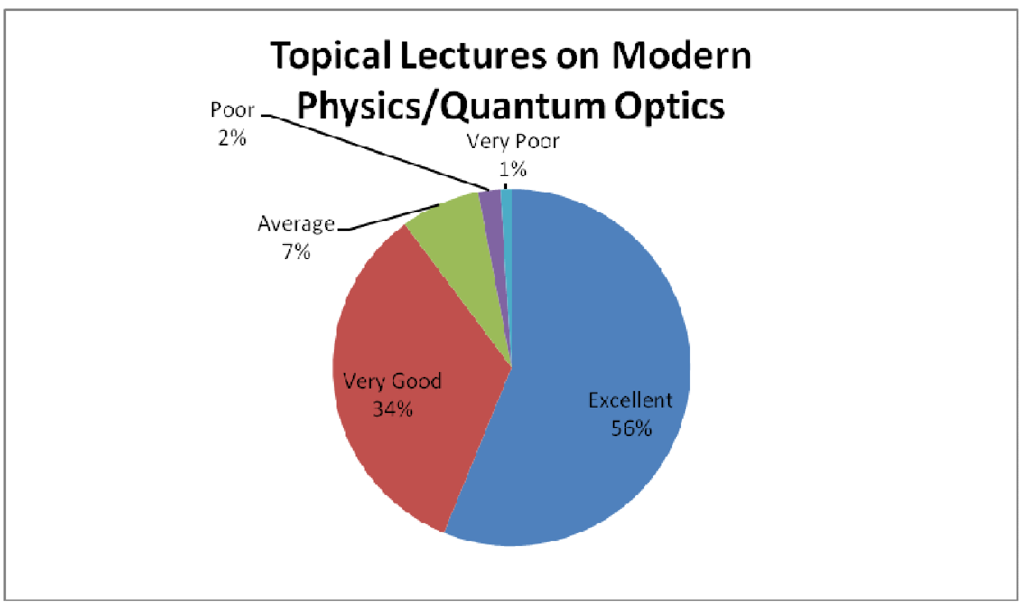


Figure 4 Topical Lectures

The percentages for this graph are an average of the responses on the Likert Scale questions that were given to each of the 7 PEPTYC groups after each of the May Institutes. Each Institute was first separately analyzed and then an average of the associated questions was then taken over the entire spectrum of responders. Approximately 90% of the respondents for the entire session rated the work of these research lecturers as excellent or very good. One additional negative remark coming from responders was these were “lectures” not “active learning”, as was being promoted throughout the professional development experience.

Laboratory Activities

Each May Institute brought about the opportunity for TYC faculty to interact in a laboratory based scenario which was designed by the researchers and project directors to accompany the topical lecture portion of the institute. These laboratories were designed to stimulate thought and interest in the TYC faculty to create their own activities which were relevant to the topical lectures given by the research professionals and could eventually be added to their own courses enriching their students with modern physics and quantum optics examples. The quantum optics laboratory was essentially an effort to try and demonstrate this cutting edge technology on both a large scale budget and a small scale budget. This was fashioned in this manner because requirements to participate in the last two cycles of the project asked TYC faculty to make a commitment to add a course or major component to their introductory courses in the area of quantum optics. Hence, the data is spread out over a somewhat broad range of activities that were designed for the laboratories section of the May institute.

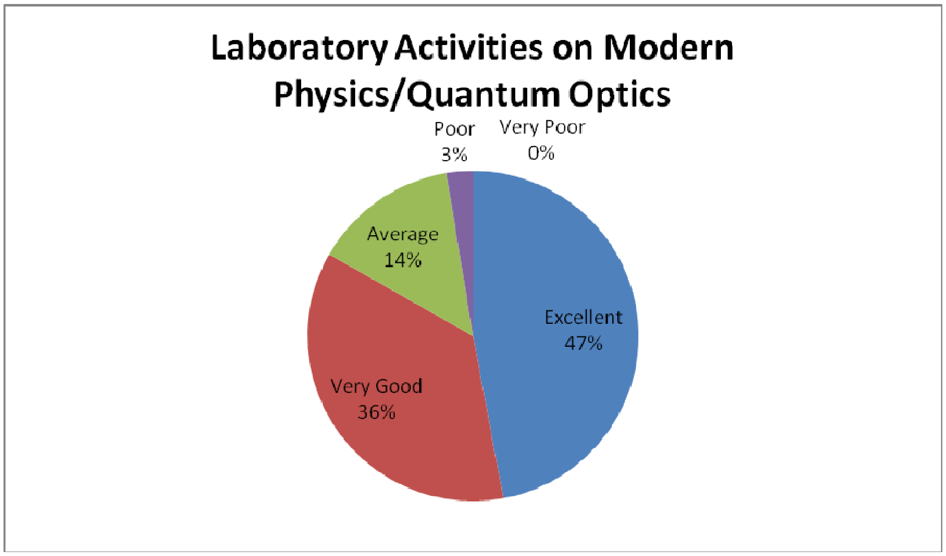


Figure 5 Laboratory Activities

Although some comments on the final evaluations were directed at the difficulty that occurred during a couple of the Quantum Optics experiences in the laboratory, Figure 5 indicates that approximately 83% of the respondents thought the activities were very good or excellent.

Pedagogical Topics (Workshop Physics and Digital Video)

Each May Institute also brought about the opportunity for TYC faculty to interact in a laboratory based scenario which highlighted a current pedagogical approach to teaching. During a number of the institutes, one method that was shared was the “Workshop Physics” approach (Laws, 1991). Many community college instructors have the facilities and the classroom sizes and numbers to use this method of instruction or some adaptation of this approach. The leadership of the PEPTYC project believed that this method of instruction, if modeled in the May Institute, would be easily adapted to many TYC faculties based upon personal style and teaching environment constraints. A number of the learning activities were done using this model of instruction and its effectiveness was surveyed at the conclusion of each of the PEPTYC cycles. The leadership didn't attempt to direct the participants into teaching their courses in this style, they just provided the participants an opportunity to explore for themselves the methods and learning that would occur in such a setting. The results of these activities are shown in Figure 6 below.

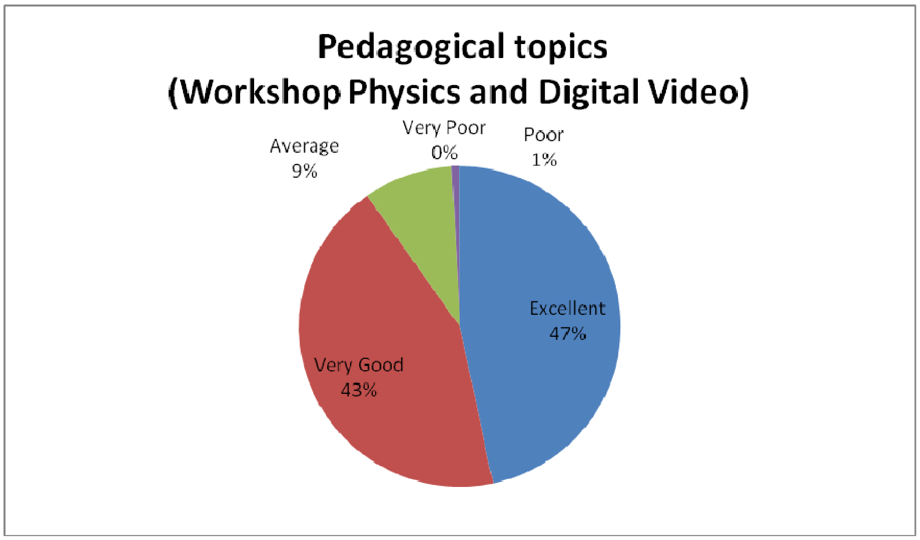


Figure 6 Workshop Physics and Digital Video

It appeared from the responses that nearly 90% thought that the sessions using the Workshop Physics approach were either very good or excellent. The approach seemed to fit the needs of these instructors as a number of specific comments addressed the unique approach that was used to demonstrate this classroom management style. The inclusion of the use of digital video analysis in this part of the data set is a natural addition. Laws (1991) and her contemporaries use Digital Video analysis as a part of their whole "Workshop Physics" curriculum package and the peer expert also demonstrated video analysis as a part of the project creation aspect of this set of sessions during the May Institutes.

Pedagogical Topics (Microcomputer Based Laboratory)

Each May Institute also brought about the opportunity for TYC faculty to interact in microcomputer based laboratory scenarios. Project leader Tom O'kuma had done extensive work with Physics education researchers and MBL curriculum designers Thornton and Sokoloff, (Thornton, & Sokoloff, 1993) providing a series of workshops as a part of his other two year college physics workshop grant. O'kuma and his lab assistant Regina Barrera, provided the necessary equipment, computers, probes, and interfaces to explore many first semester and second semester common topics and experiments from introductory physics during this phase of the May Institute. After providing time to "perform experiments" from the basic curriculum packages, participants were encouraged to explore on their own and create, modify, or develop entirely new experiments which could be used in their own classrooms and shared with members of the group. These MBL experiences were a highlight for a number of the participants as can be seen in Figure 7.

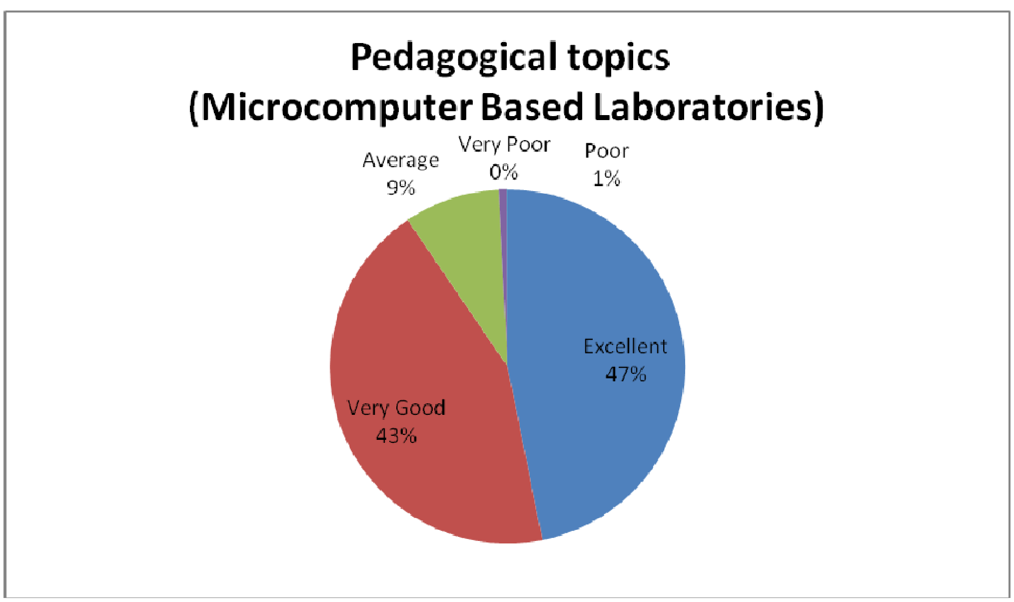


Figure 7 Microcomputer Based Laboratories (MBL)

Again, an analysis of the information from the end of the Institute survey shows that the satisfaction level of the participants at a minimum of very good was at 90%. Exposure to these MBL tools seems to be at a level which TYC faculty could become informed decision makers when attempting to decide on whether these types of materials would be effective or useful in providing instruction for their own students.

Pedagogical Topics (Assessment and Evaluation)

Assessment and evaluation became hot topics in both the physics education research field and the general field of education itself during the 15 years of the PEPTYC projects. Assessment of students' pre-conceived knowledge in physics brought out a series of research articles based upon testing instruments that had been developed by these researchers during the latter part of the 20th century. The plethora of acronym named tests included things like the FCI, MBT, and the CSEM. A number of these surveys/tests were discussed, administered and studied during the various May Institutes. Additional evaluation practices were also shown and their implementation processes were demonstrated as a part of the program's effort to introduce these topics to its participants. Comments on the post institute survey showed the researcher that although these physics education research based products were available in the literature, a number of the participants were unaware of them or their uses in the classroom. The following data shows the effectiveness of the project in exposing the participants to this material.

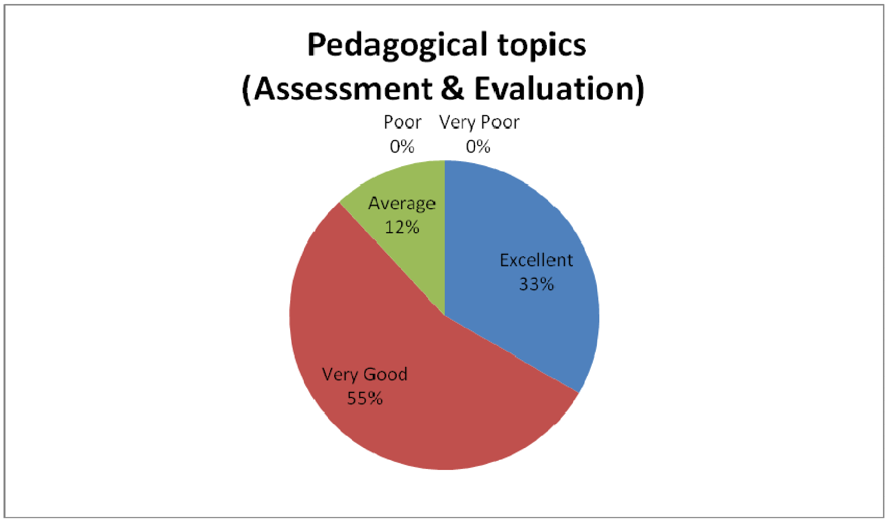


Figure 8 Assessment and Evaluation

The data in Figure 8 shows that 88% of the participants rated the sessions on Assessment and Evaluation as at least very good. A couple of comments in the survey showed that an occasional instructor didn't think that these assessment tools would be very useful. They felt they already reached their students and that a little more hard work on the students' part would make the misconceptions go away. This was an interesting comment for the researcher as even after the program leadership provided research articles, such as Hake's (1998) interactive engagement effectiveness article, that some instructors were still unsure of the effectiveness of these tools. The researcher notes that changing the minds of instructors is sometimes as difficult as changing 'misconceptions' in the minds of students.

Pedagogical Topics (Program Innovations)

While many of the TYC faculty who attended the PEPTYC program taught at transfer based institutions, a number of them had technical programs which were essential to their teaching and teaching loads. Technician training, pre-medical and pre-engineering programs were all included in the various activities related to the program innovations. A number of innovative methods of instruction, such as teaching physics in "large context", or with problem based strategies were demonstrated by both the leadership group and the participants. Use of curriculum materials specifically designed for technician training as well as modular training programs impacted the learning for the PEPTYC program participants. The results of these innovations as seen by the participants are shown in Figure 9.

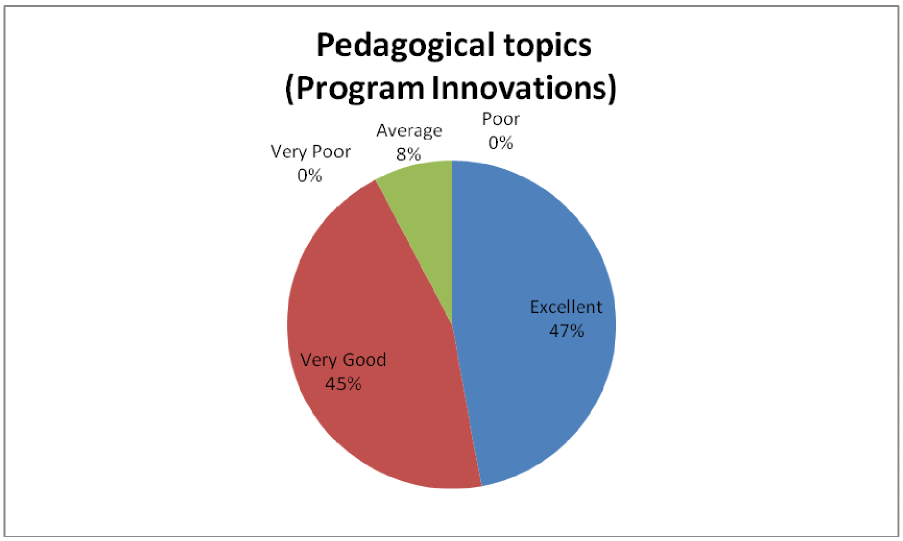


Figure 9 Program Innovations

Again the cumulative responses of the participants from the different cycles and different post institute surveys show a common trend of almost 9 out of every 10 participants felt the program did at least a very good job exposing them to the recent and innovative program details associated with this learning objective.

Pedagogical Topics (Curriculum Innovations)

Dissemination of curriculum innovation was an underlying objective of all the programs that were sponsored under the PEPTYC model. As Robert Beck Clark (2003) put it, "It was like a big bazaar, a place where people could explore or pick and choose the innovations that were best suited for them.". Each time a May Institute came around, the program leaders looked at new and innovative curriculum ideas and added to their "bag of tricks". Eventually, a list of curriculums, both full course and partial packages was put together and the final group of PEPTYC teachers had been exposed to nearly 20 different sources of curricular material and classroom management ideas. The response to this part of the post Institute survey shows that this exposure was 96% effective with approximately 4 of the 100 participants thinking that it was only an average experience. This can be seen in Figure 10.

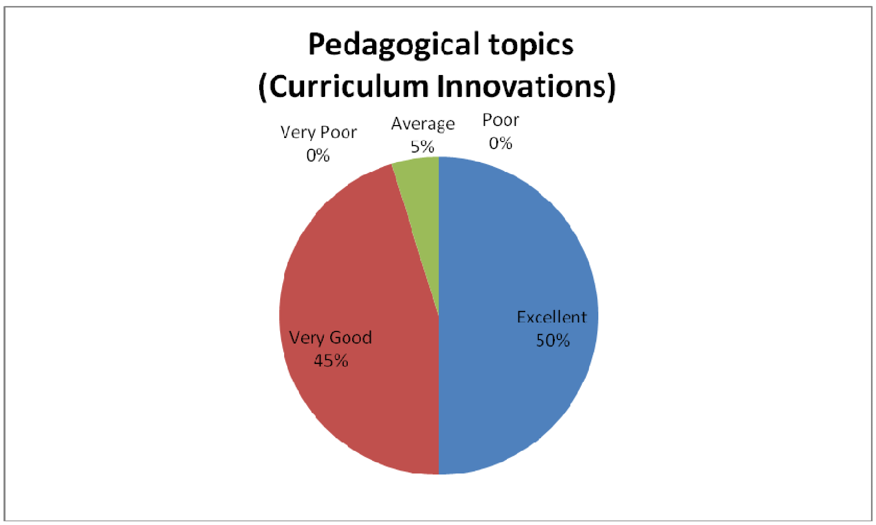


Figure 10 Curriculum Innovations

Many of the written responses to the introduction of the various curriculum innovations showed common positive responses such as, 'I can't wait to try some of this when I get home" and "I am glad I have all summer to think about how to incorporate this material into my classroom, it's a lot of stuff, but a lot of good things I want to try".

Pedagogical Topics (Physics Simulations and Web Resources)

Many of the two year college faculty who were in the first 3 PEPTYC programs were on the cutting edge of technology with respect to its use as a communication form. Most of them didn't have e-mail when this program started. By the time that the PEPTYC

IV group was meeting at Texas A&M University for their first May Institute, this researcher's school, Cloud County Community College, finally issued e-mail addresses to its entire faculty. As a participant, an assumption was made that the rest of the instructional world was well ahead of this little rural school in Kansas. Attending this program as a participant, a hope surfaced that others were without this communication technology. Eventually, this researcher realized that many schools and instructors were just getting e-mail too. However, once the PEPTYC IV group was finished, all the other participants were keenly aware of e-mail, and the new uses of the World Wide Web to teach physics. The e-mail use for communication would no longer be a problem as each group after PEPTYC IV seemed to be quite aware of this technological thrust as well as the dynamic world of teaching using physics simulations and web resources which would have an underlying driving effect on a number of the sessions that were presented each year at the PEPTYC institute. This set of data shows that even though this aspect of the program was in a constant state of flux, that the participants felt they were learning essential information from their peers and that the information was something that they could share openly with their colleagues while not feeling nervous or underprepared for learning about it. The technology and the assistance from the program directors and participants had an excellent "calming effect" according to a number of the less "techno savvy" participants in the program. The data in Figure 11 shows that 91% of the participants felt very good about the information related to these technological innovations that were introduced at various levels of the program's May Institutes.

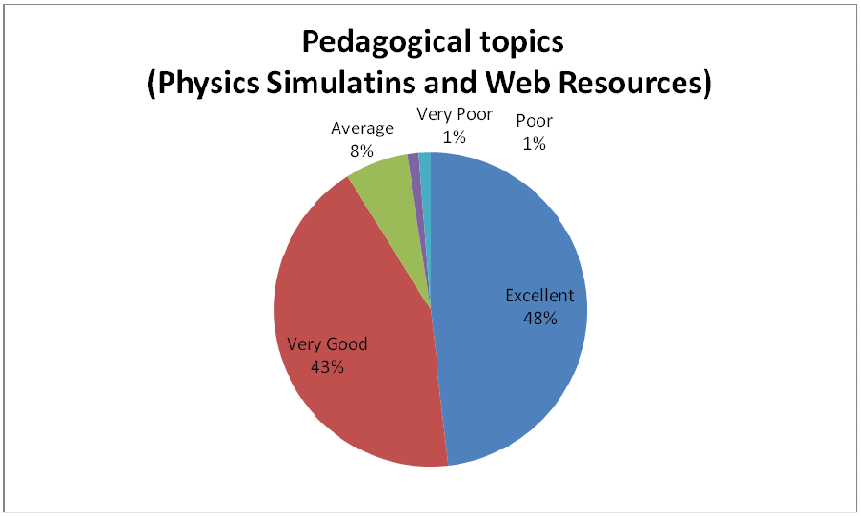


Figure 11 Computer Resources

Pedagogical Topics (Cracker Barrels)

The term "cracker barrel" was unique to the flavor of activities that occurred at the PEPTYC May Institutes. It is a term that is associated with "Texas ranchers" sitting about the general store talking about the issues that were affecting them at that time. Cracker barrels were a catch all for ideas and information sharing that occurred via group discussions and quick presentations. Cracker barrels took many different shapes and forms, sometimes they represented lecture discussion sessions while other times they were done in a classroom management style known as discourse management (Desbien, 2002). The social interaction of cracker barrels brought together instructors in a nonthreatening way to "cuss and discuss" and share the ideas that would shape the future of physics teaching at the two-year college level. Each of these sessions were unique and changed over the course of 15 years, but they each had a well thought out purpose and objective. Their effectiveness as seen by the participants is shown in Figure 12.

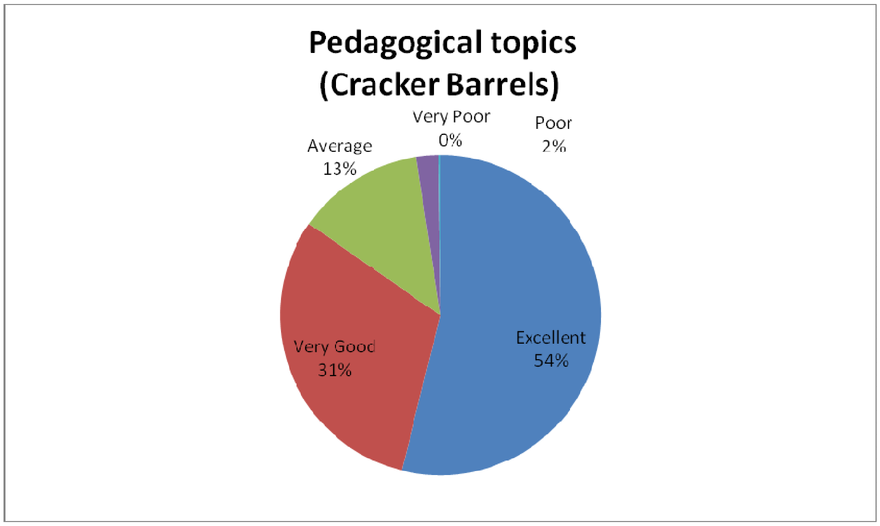


Figure 12 Cracker Barrels

During PEPTYC III and IV, the TYC 21 project was fully underway. This was a time in the history of physics teaching at two-year colleges when a number of the national leaders were attempting to build a visible network of instructors who were actively leading other teachers in the pursuit of teaching excellence at the two-year college level. Cracker barrels were often times the "process" that was used to start and carry on discussions in this community.

Pedagogical Topics (Sharing Sessions)

After reviewing the participant comments from the surveys given at the various PEPTYC cycles, one thing that always came out was the importance of the sharing sessions. Participants often felt that they didn't initially have anything that was significant to show their colleagues. This was especially true during the first year of the two year cycle. After spending time with each other and attending the Fall and Spring Texas section meetings, giving "shared presentations" become second nature for the participants. Almost always the second year of sharing was exceptional. During these sessions the participants were able to highlight their programs and their personal changes and achievements as teachers. This was always an unthreatening situation where the collective groups of PEPTYC colleagues gained insight into the difficulty and success that their peers had when adapting new methods and ideas that were inspired by the PEPTYC program. Written comments prevailed throughout the surveys regarding the significance of the sharing sessions. The summarized data from the seven PEPTYC cycles is shown below in Figure 13.

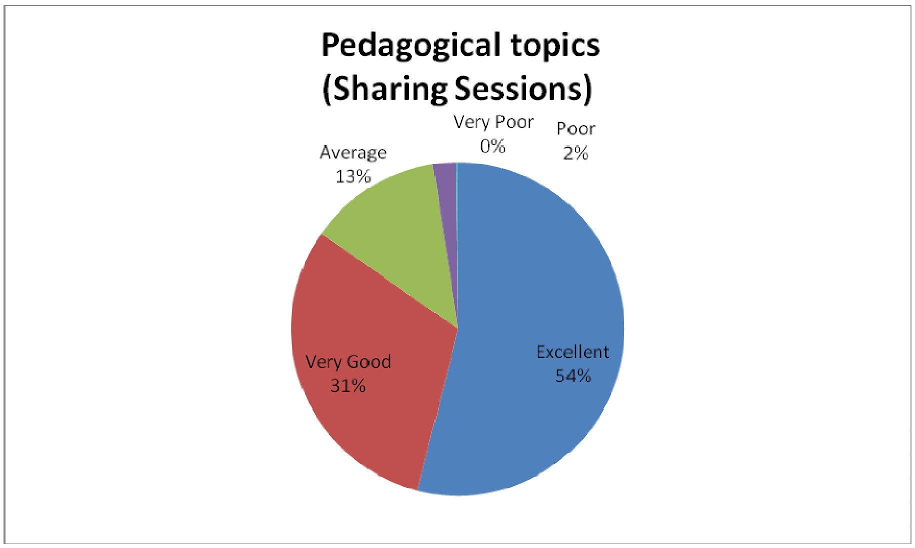


Figure 13 Sharing Sessions

Oftentimes participants would note that they had never presented papers at a physics teachers meeting before. One of the “requirements” for the graduate credit at the PEPTYC Institute was to give a paper or a workshop presentation during either a regional or national AAPT meeting. These sharing sessions helped give confidence to a number of presenters and started an initial chain reaction for the participants to give these types of presentations at their sectional AAPT meetings. This is evident based upon the number of papers and workshops that are seen in the various reports from the AAPT central office. During the grant period, the leadership team attempted to keep track of the number of these presentations. Noting that at a minimum, each participant became active in this scholarly endeavor. This data is also supplied in Table 8 of this report.

Pedagogical Topics (Group Lunches and Dinners)

Immersion into a program can be beneficial to its participants. PEPTYC leadership believed that if the participants were actively focused on tasks during the majority of the May Institute, they would benefit at the greatest possible level. Occupying all the participants time, however, was something that didn't always lead to effective programs. Almost every PEPTYC program had participants who asked for more "down time". Often times this "down time" was requested to process information, relax, workout, or release their tensions. Some surveys requested time to tour more of the facilities, while others asked for more time to "sit and think" about the materials that had been shown to them.

None the less, group lunches and dinners provided time for the participants to spend time together talking about family, hobbies, and ideas that needed to be shared with colleagues. Isolation for a two-year college physics teacher is prevalent throughout the teaching community. TYC 21 found that many programs only have one physics faculty member associated with them and a sense of community is often lacking. Some people enjoyed that isolation while a number of people felt the need to have a learning community available. The data related to the participants' thoughts and feelings about the group lunches is shown in the following Figure 14.

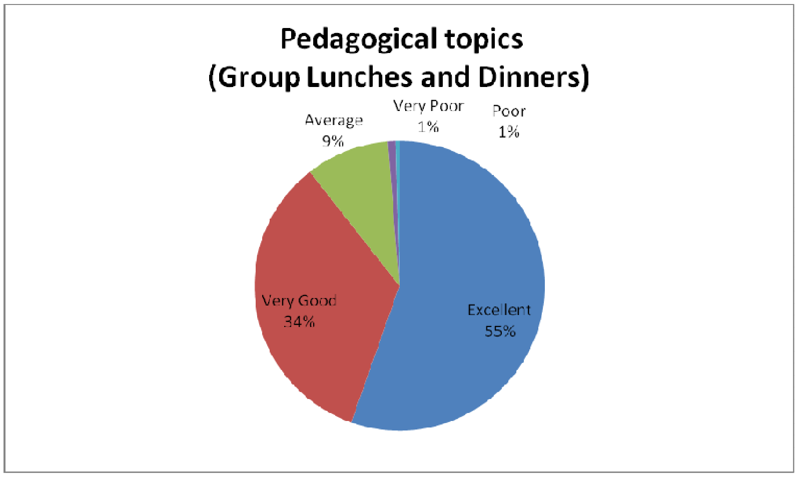


Figure 14 Group Lunches and Dinners

Social construction of knowledge can take place in many places and under many forms. Whether it occurs in small working groups, with dorm roommates, or across the table at the local pub, one of the most enjoyed activities by the PEPTYC groups seemed to be the collegial interactions that were associated with the program.

Meeting the Needs of Faculty Members

Most evaluations of professional development programs are attempting to determine whether or not the participants were satisfied with the program as a whole. Did the program meet their needs as teachers and did the program provide the motivation to continue to learn as well as promote change within their own curriculum and philosophical views of teaching. No single question can really assess this; however, the PEPTYC leadership did ask the participants to express their "happiness" with the overall project via the question, "How well did this program fit my needs as a two year college physics instructor". The data associated with this question is presented in Figure 15.

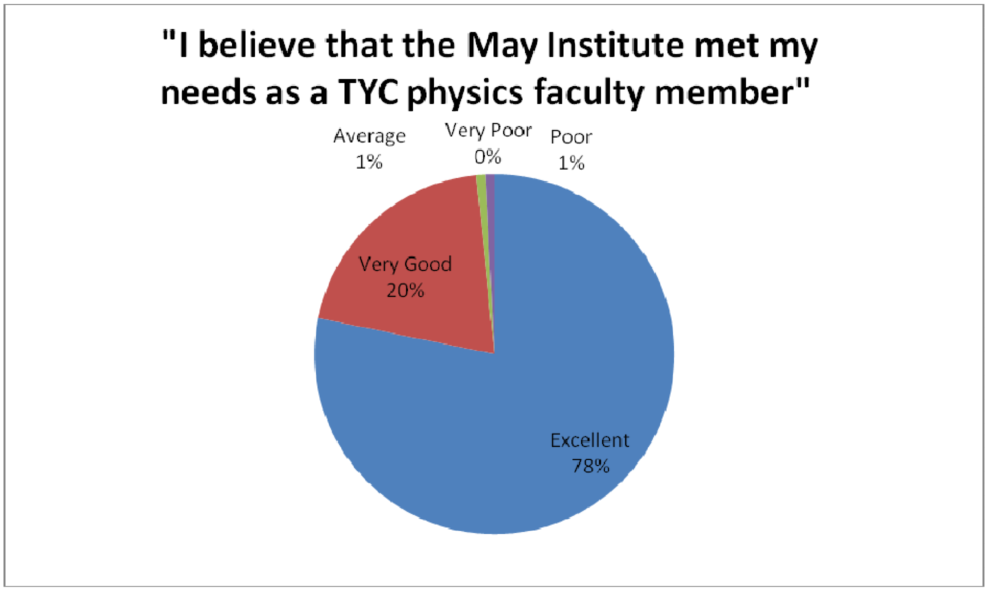


Figure 15 May Institute: Meeting Needs of Faculty

Many evaluation experts would say that a numeric percentage of 98% satisfaction was exceptional for a program such as this one. The leadership team continued to "tweak" the program a little bit here and there after each set of evaluations came back and the trend of satisfaction continued at this very high level. The minor changes in the program usually were driven by either a technological change or recent research endeavors that had been presented at other regional conferences. It was kind of like adding another flavor to the already full smorgasbord. Each time a small change was made, it was done so in an effort to listen to the likes and needs of the participants as well as to create the most current, up to date pedagogical possibilities for the participants.

Participant Reactions: Modern Physics Component

While exposure to new teaching methods and community-building were important secondary goals of the program, raising two-year college faculty familiarity with quantum optics or modern physics topics, and preparing them to teach these subjects was a central objective of the PEPTYC project. The level of familiarity the teachers felt they had with aspects of these topics at the conclusion of the first two-week session was promising. It continued to be even more promising at the final stage of the program evaluation a year later. Teachers felt better prepared to teach some of these same aspects of modern physics and quantum optics topics. Impressive gains were made in the participants' familiarity with these modern physics concepts and in their preparation to teach those concepts. Low gains in every case began as high knowledge levels at the beginning of the program. By the end of the sessions nearly 80% of the respondents felt comfortable in describing themselves as moderately to extremely familiar with quantum optics concepts and moderately to extremely well-equipped to teach those concepts.

Participants were asked about the most valuable lesson that they would take home from the program. Many people, (67%) cited their new-found appreciation for modern physics and quantum optics concepts, while others (72%) focused on ways of teaching these concepts, and how physics labs could be reshaped to integrate such topics. Another theme (70%) was reawakened excitement over physics teaching in general, and a sense that others shared similar problems and triumphs. A typical comment was, "(I learned) that it is important to blend application with theory. Dr. Walther made most of the very difficult topics understandable because he always provided their use." Such statements illustrate the success of the program in combining substantive new material with techniques for presenting it to students. Additional comments focused on "an appreciation for quantum theory and a renewed enthusiasm for teaching" and "interaction and involvement with others..."

Participants in the program were required to develop an at-home project to implement the modern physics instruction received during the program. At the end of the first May Institute, participants submitted their plans for this effort. After the second institute, final efforts were discussed and then documented after follow-ups during the year. Nearly 73% of the projects involved integrating modern physics or quantum optics topics into their current courses, adding labs to these courses, and developing additional courses which would include either a modern physics base or a quantum optics module; although, in a couple of instances, less than 10% of the participants had hopes of starting a course or even a program dedicated entirely to either quantum optics or an expanded offering of a third semester modern physics course. The researcher summarized these plans as follows: Many participants focused not only on the substance of these plans, but also expressed their excitement about the chance to add new technologies to their physics courses; which they hoped would heighten student interest and keep them more up to date. Comments focused on, "The chance to provide students with some '20th' century physics" and "Sharing what I have learned (some of it anyway) with my students and hopefully seeing them get excited about photonics too."

Participants Reactions: May Institutes

All of the seven May Institutes could be considered a success in nearly all aspects. Participants expressed high levels of satisfaction with the quality of instructors and enthusiasm for other participants, the quality of instruction, and the topics covered (quantum optics, modern physics and other pedagogical areas). Every single participant surveyed by internal evaluation instruments said that they were very glad to have participated in their conference and that they would recommend the program to other two-year college faculty. According to the evaluation surveys, the major goals of the program seem to have been met with dramatic improvements in the self-assessment of the participants on their familiarity with quantum optics and modern physics concepts, their preparation to teach those concepts, and their eagerness to do so. Participants especially enjoyed the opportunity to interact in an academic setting after being out of school themselves for many years and seemed genuinely enthusiastic about integrating either the quantum optics or modern physics topics into their own physics courses and programs.

The data source from the previous evaluation process provided the researcher with a great deal of rich and descriptive information. This summary helped set the foundation for the analysis of the e-mail survey and in-depth interviews that the researcher conducted as the second and third parts of data collection.

PEPTYC Project Outcomes: A Statistical Review

The researcher examined a number of specific examples of products that were produced by participants during the fifteen years of the PEPTYC project. These outcomes included; courses that were developed, papers that were presented and workshops that were presented, as either a direct or indirect response to the PEPTYC project. Many of these products were sent to participants as “mini-lab manuals” or “sample curriculum adaptations”. Additionally the papers and workshops presented by various participants and project leaders at AAPT meetings across the nation were an “outcome” of this project. These project outcomes have been tabulated and attributed to the program. These are shown either in graphic forms, such as Figure 16 below, or as lists of data in tabular form, such as Table 8, in the following sections.

Outcomes: Papers Presented and Workshops Presented

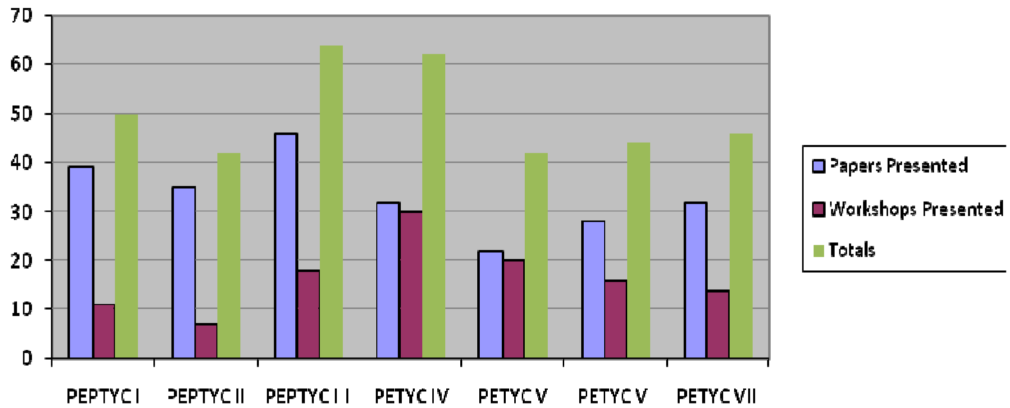


Figure 16 Outcomes

Figure 16 shows that the active participation in physics teachers meetings outside of the institute remained consistent. The group produced approximately 1 paper or 1 workshop presentation per participant each year of the project at various state and national meetings. These were tabulated from national AAPT meetings and Texas Section AAPT meeting and don't include additional papers or presentations beyond these two venues. They are listed in Table 8.

Table 8 Scholarly Activities

1. PAPERS PRESENTED BY PEPTYC I-VII
   39 papers presented by PEPTYC I participants and staff
   35 papers presented by PEPTYC II participants and staff
   46 papers presented by PEPTYC III participants and staff
   32 papers presented by PEPTYC IV participants and staff
   22 papers presented by PEPTYC V participants and staff
   28 papers presented by PEPTYC VI participants and staff
   32 papers presented by PEPTYC VII participants and staff

2. WORKSHOPS PRESENTED BY PEPTYC I-VII
   11 workshops presented by PEPTYC I participants and staff
   7 workshops presented by PEPTYC II participants and staff
   18 workshops presented by PEPTYC III participants and staff
   30 workshops presented by PEPTYC IV participants and staff
   20 workshops presented by PEPTYC V participants and staff
   16 workshops presented by PEPTYC VI participants and staff
   14 workshops presented by PEPTYC VII participants and staff

Outcomes: Curriculum Products Produced

Of the numerous written products that were produced by members of the PEPTYC project, two examples will be discussed in this section. First, "*Introductory College Physics in the 21st Century*" was a curriculum project created by Alex Dickinson and a select group of two-year college physics instructors. The curriculum project was an outgrowth or extension of TYC 21, PEPTYC, and the Workshop Physics projects. It was marketed by ZTEC Incorporated under the name ICP21 (*Introductory College Physics in the 21st Century*). The curriculum was an adaptable set of modules that were based on technical applications as they related to training a technical workforce at the two-year college. Of the principle authors of this project, at least 50% of the materials developed were done by participants or members of the peer teaching leadership group from the PEPTYC project. Many of these authors were recruited because of their efforts and connections from within the PEPTYC project. Secondly, mini-lab manuals and curriculum project creations were produced during each of the seven cycles of PEPTYC. Participants were given copies of these projects on a medium which was adaptable for them to use in their own teaching if applicable. For example, the PEPTYC VI project produced an in-house lab manual which covered approximately 12 different laboratory activities ranging from Kinematics to Optics and included an idea to simulate a scanning tunneling microscope using a magnetic field probe and mystery objects. Contributions to the active learning manual "Ranking Tasks" published as a part of the Prentice Hall Education Innovation Series, and co-authored by Tom O'kuma, were also credited with some origins in PEPTYC.

Outcomes: At-Home Projects

Numerous "At-Home" projects have occurred over the seven PEPTYC cycles. The "At-Home" portion of the project included a final report of the projects that were done by the participants and were a requirement for the receipt of the graduate credit for the course from Texas A&M. These activities were always reported on at the Texas Section meetings and then a final summary narrative was sent to Dr. Clark. Some examples include: the development of a suitcase physics program; the development of instructional materials for accelerator, particle physics, and quantum optics topics for introductory courses; and a number of special or topical courses in technical physics. Additionally, members of the PEPTYC project provided impetus for additional modules for the Introductory College Physics in the 21^{st} Century project too.

With almost 100 different participants over the years of the project, these "At-Home" activities covered a wide variety of topics, too numerous to list. However, as an example of the diversity of projects, the researcher highlighted a few of the things that were reported on by various participants of this program. The majority of the participants reported that these "At-home" projects were new activities for them and that "They were definitely something that I wouldn't have done before the participation in the program." The activities included: the creation of a news paper column "*Ask the Physics Teacher*", several efforts to provide some type of on-campus "Physics Olympics"; and the creation of numerous curricular enhancements for physics courses, such as creating ranking tasks, peer instruction questions and a "Just in Time Teaching" website. For many of the participants, their continued curriculum material development also included the creation of modules for the previously mentioned Introductory College Physics in the 21^{st} Century

Program. Still, other participants became active after the program through the creation of a resource package for integrating mathematics and algebra-based physics on their technical community college campus; while another secured funding for online/video instruction at both his campus and a satellite campus as well. While not everybody secured grants or created curriculum, each participant shared ideas that they brought from their learning experience and reflections of the process back each follow-up session of the program. The informal and formal sharing of these ideas was yet another way for the PEPTYC participants to receive the follow-up support and mentoring that is usually associated with good professional development practices.

Outcomes: NSF and Other Funded Projects

Several funded projects were reported on by the participants in this program over the seven cycles. These reports included NSF ILI grants and other funded projects. The creation of qualitative reasoning problems, an integrated/combination calculus-physics course, an interdisciplinary problem set project, a studio based MBL make over and an active astronomy lab program are just a few examples of the funded projects that were undertaken by the various participants.

In addition, a number of the participants reported that by using the “leverage” of attending the program they were able to perform numerous laboratory "upgrades" that were furnished by their respective colleges. An excerpt that will be expanded on in great detail later in this chapter notes:

> “I applied for money to develop an online offering of the first term of Calculus-Based Physics over the Web ... I was awarded the money for

release to develop the course … I was excited as this was the first time I had submitted a proposal for external funding to my college."

Approximately 65% of the participants from the group would come back to the follow up AAPT meetings and make statements related to the ability to leverage their PEPTYC experience into a positive administrative response for new equipment, new courses, or new changes in the programs where they were working. Many of these were externally grant funded or internally supported by the individual institutions where the instructors worked. This type of additional support is talked about in the literature as being essential for good professional development to be sustained within a teaching environment.

Comparison of Three Sources of Evaluation Questions:

What did the participants like the best about the PEPTYC program, and what did they like the least? These were two specific questions that were asked by in the following data collection efforts. Initially they were asked on the end of the May Institute surveys. This was done by the principle investigators of the project, Dr. Clark and Tom O'kuma and was found in the pre-existing documentation of the project. Secondly they were also asked by the AIP research team in a similar "end of project evaluation survey", also found in pre-existing documentation. And thirdly, they were asked on both the e-mail survey instrument, which went out to nearly all participants of the project, and the questions were also repeated during the in-depth interviews that were done on the 14 purposefully selected participants, by the author of this research. Multiple data sources collected by multiple people, specially improved the reliability of outcomes from this research. When AIP researched the QU-OP (CYCLE VI-II) of the program, these two specific questions were asked in the general evaluation of the project. The questions were paralleled to two similar questions that were asked on the final exit surveys done by Clark and O'kuma, which were key data sources available from the project. The researcher used these questions to assist his effort to triangulate the data from each of the various sources used for this research. These specific data sources were blended to produce the answers described in the following two sections. They are offered as a transition from previously gathered data by the projects' internal and external evaluation sources and product outcome sources, into the data that was acquired specifically by the researcher in his e-mail survey efforts and individual interview efforts.

What did you like best about the program?

In each of the data sources that were examined, the participants responded with comments related to both the pedagogical approaches and the modern physics/quantum optics topical lectures and laboratory experiences. These answers have been melded into a summary which shows the reader what a common sample would look like. A typical (85 %) respondent made statements such as, "I liked the variety of activities, descriptions of other teaching methods, and the exposure to physics education research." Respondents also noted that, "The informal and formal sharing sessions and ability to have communication with the participants and program leaders was great." While adding the following type of statement, "The interaction with peers and the opportunity to behave like the student again was great, the PETYC project, provided me with a chance to view material which I have not viewed for a very long time, it gave me a chance to interact with other colleagues and see what they do, and it provided new avenues to explore."

Examples of participant responses to the specific modern physics/quantum optics sessions and laboratories provided the following type of information,

> "The morning lecture on quantum optics and modern physics topics and opportunity to visit research labs was a great experience for me. The hands on experience with the quantum optics equipment were also great. Overall it was a good combination of theory and applications and it should be expanded and given more NSF funding."

While other respondents noted, "I also enjoyed the computer work and the research lab tour. It was a good mix of different topics and presentations."

<u>What did you like least about the program?</u>

When comparing the results from the three data sources it appeared that an almost unanimous feeling arose from the participants. They responded with comments related to both the pedagogical approaches and the quantum optics topical lectures and laboratory experiences. These comments are also synthesized into the following typical answer, "I really didn't have any things I didn't like." Concerns of the program included,

> "The only disappointment was with the quantum optics lab activities, but you have to start somewhere. Some of the labs were tedious, and we had inadequate equipment, and insufficient instructions to do them. I was frustrated but I know that this stuff is on the cutting edge of research right now."

A statement which supported a negative response to the program that appeared usually in the context of a participant who had been through the TYC 21 project was. "The cracker barrels didn't turn my crank, I guess because they ended inconclusively." While others stated, "There was no part that I didn't really like, but if I had to pick, perhaps methods of assessment." And still another noted,

> "We were pretty rushed most of the time. I also didn't like the heat and humidity of College Station, Texas. But overall, the program was great and my complaints are really minimal at most."

And finally one negative that was based upon the lecture presentations of the experts in the field,

> "I did think it was ironic that during the pedagogical sessions you taught in 'active engaging styles' but in the research content delivery sessions the traditional form of instruction prevailed."

The two questions were the single best indicator of the reliability level of this research. Since they provided the researcher his best effort of analyzing three different data sources, gathered at three distinctly different times during the research process, each showing consistent results and thought patterns of participants.

Individual Interviews:

Fourteen individuals agreed to participate in both the e-mail survey and individual interviews for this research. The researcher made initial decisions to narrow down the general population of PEPTYC participants into these 14 individuals based upon the separation between the 7 instructional groups or cycles of the PEPTYC project. This number included 2 from each PEPTYC cycle. Of those interviewed the participants whose time schedule was not in conflict with the interviewer's schedule was also considered. Therefore, sampling was not random due to several practical issues. The ratio of interviewed female and male participants was 5:9, which is really similar to the ratio in the PEPTYC projects general population (37 females and 58 males unduplicated headcount). Of the entire group of participants who were e-mail surveyed, and then asked to participant in an individual in-depth interview, the most important data source for this study, were the 14 specific faculty members who were interviewed, after the e-mail survey was completed.

The PEPTYC participants who agreed to participate in the e-mail survey and individual interview process were not the entire population who attended the PEPTYC programs. Nearly 100 participants had participated (95 unduplicated head count), with the e-mail survey going to the participants who were still teaching at a two year college. A number of participants have retired, passed away, or have moved on to administrative and industry jobs since their participation in the program. The researcher accomplished the final analysis of his research goal through individual interviews of 14 participants who participated in one of the 7 PEPTYC Institutes. At this stage of inquiry the researcher began to search for themes that fell out through the analysis of the data. This section of descriptions and discussion will be highlighted under the individual interviews heading. From this data the researcher can discuss pre-post PEPTYC professional development effectives and the programs' dynamics. The researcher called this part of the data, the main research sample. All others who were surveyed via e-mail but were not interviewed will be referred to as the supplementary sample, for this projects' conclusion. The supplementary sample in some ways helped the researcher develop additional insight into the entire program known as PEPTYC. The following Table 9 shows a very general synopsis of the participants who were interviewed. Table 9 also shows the coding scheme used by the researcher for this project. As one can see, 14 different participants were selected, two each from the 7 different cycles of PEPTYC.

Table 9 Coding Schemes

CYCLE Number	CODE Number	Teaching Experience	Personal Enrichment	Student Improvement
PEPTYC I	JM11H	>15	Y	N
PEPTYC I	JM12O	>15	Y	S
PEPTYC II	MF21M	>15	S	Y
PEPTYC II	EM22B	>15	Y	N
PEPTYC III	MF31P	>15	Y	Y
PEPTYC III	DM31W	<10	S	Y
PEPTYC IV	BF41K	<10	S	Y
PEPTYC IV	TM41Z	>15	Y	S
PEPTYC V	SF51D	<10	Y	S
PEPTYC V	BM52E	>15	S	Y
PEPTYC VI	TM61M	<10	Y	Y
PEPTYC VI	JM61G	<10	Y	Y
PEPTYCVII	SM71S	<10	S	Y
PEPTYCVII	MF71W	<10	N	Y

In the overall data set there were 5 females and 9 males. This was actually reasonably close to the demographics of the overall program, with a male to female ratio of almost 2 to 1. The chart shows three columns that were significant to the researchers when examining the data for themes. These included a teaching experience split of greater than 15 years or less than 10 years. Table 9 also includes columns that are labeled "Personal Enrichment" or "Student Improvement". These were assessments of a "primary" reason for actually applying for the program that was determined by responses to the pre-interview questions. These codes are used in the research to identify statements that were a part of the interview and survey process.

Demographically speaking, the PEPTYC participants who agreed to participate in the e-mail survey and individual interview process had various degrees which ranged from B.S.- Ph.D.'s in Physics, years of teaching experience ranging from 3 years to over 30 years and taught at numerous different types of two-year college physics departments, ranging from single department member, small enrollment, rural to large departmental, metropolitan type institutions. A description of the 14 volunteers from the PEPTYC participant pool with respect to the entire PEPTYC participant pool is shown in the Table 10 below.

Table 10 Interview Pool Comparison

Code: Gender, Number of years teaching today (at time of program), Degree today	**Code: Total, # Male # Female, average teaching years, Degree type #MS, #PhD**
JM11H-PEPTYC I Male 20(7) years teaching, MS Physics	PEPTYC I -Group 24 total (21M, 3 F) 14 years, 16MS, 5 PhD
JM12O-PEPTYC I Male 25(12) years teaching, MS Physics	
EM22B-PEPTYC II Male 29(16) years teaching, PhD Physics	PEPTYC II –Group 21 total (16 M,5 F) 14 years, 14 MS,7 PhD
MF21M-PEPTYC II Female 35(22) years teaching, MS Physics	
MF31P-PEPTYC III Female 30(19) years teaching, PhD Physics	PEPTYC III –Group 23 total (16 M, 7F) 13 years, 18MS,5 PhD
DM31W-PEPTYC III Male 25(14) years teaching, MS Physics	
TM41Z-PEPTYC IV Male 16(6) years teaching, MS Physics	PEPTYC IV –Group 24 total (17 M, 7 F) 8 years, 18 MS, 6 PhD
BF41K-PEPTYC IV Female 15(5) years teaching, MS Physics	
SF51D-PEPTYC V Female 15(7) years teaching, MS Physics	PEPTYC V –Group 19 total (14 M, 5 F) 9 years,14 MS, 5 PhD
BM52E-PEPTYC V Male 15(5) years teaching, MS Physics	
TM61M-PEPTYC VI Male 15(5) years teaching, MS Physics	PEPTYC VI –Group 21 total (17 M, 4 F) 9 years, 16 MS, 5 PhD
JM61G-PEPTYC VI Male 18(10) years teaching, PhD Physics	
SM71S-PEPTYC VII Male 12(4) years teaching, MS Physics	PEPTYC VII –Group 24 total (16 M, 8 F) 8 years, 17 MS 7 PhD
MF71W-PEPTYC VII Female 5(1) years teaching, MS Physics	

The majority of participants taught 2 semesters of algebra based physics and 2 semesters of calculus based physics as their standard loads. To fulfill the rest of their instructional loads, classes such as Physical Science, Mathematics, Chemistry, and Technical Physics were oftentimes included as their basic instructional load.

Description of the Interviewed Participants:

The participants from the PEPTYC project, who volunteered for e-mail surveys and interviews, were motivated to assist the researcher because they felt the program had helped them and they felt a desire to document the impact of the program. Data was recorded from a number of respondents from the e-mail survey portion of the research. This data was used to create a general summary of the ten questions that were asked to the participants. This e-mail survey can be found in Appendix B of this dissertation. A limited number of direct quotes are included in this presentation but are not identifiable to protect the rights and privacy of the participants. They are however, attributed to a code as used by the researcher and listed in Table 9.

From the seven basic PEPTYC institutes, the researcher had a minimum of 5 volunteers from each group who were willing to be interviewed. These people were then purposefully selected to represent the general population in terms of gender, ethnicity, experience and ages. For example, from PEPTYC I, there were 10 total female participants and 14 male participants; a population of 24. Of these 24 original participants, 15 responded to the e-mail survey and 8 volunteered to participate in the interview. The number of participants who responded to the e-mail survey of all PEPTYC groups was really quite large ranging from 60%-71% depending upon which of the PEPTYC May Institute cycles were looked at. This didn't really surprise the researcher since the non-responders tended to come from the category of no longer teaching, deceased or retired. The researcher actually returned to Texas A&M for a Texas section meeting in the fall of 2007 and talked face to face with nearly 30 participants who attended the initial PEPTYC I and II cycles. While he didn't interview them all, the researcher was able to get information about "colleagues" who had retired, or were no longer active in the teaching field. Otherwise, if the participants were still teaching and could be e-mailed, they tended to complete the survey and the majority was willing to be interviewed.

The exact questions that were asked on the surveys are listed in Appendix C, as well as placed before the summary of each of the responses. The following is a complied summary of information from the series of narrative responses looking for comparable themes from the respondents. These responses represent the 14 responses from participants who were representative of each of the 7 cycles of PEPTYC. The researcher made an effort to highlight the specific themes at the end of each of the sections that were substantiated as part of each of these data sets.

Participant Perceived Goals of PEPTYC Project

The first question asked in the interview was "In your opinion what was the PEPTYC project trying to accomplish (goals), locally, regionally, and nationally?"

Seventy five percent (75%) of the people interviewed thought that PEPTYC had the ultimate goal of improving TYC physics students' learning of physics through the professional development of TYC physics faculty. By providing research-based pedagogy along with engaging physics content development, participants stated that they learned how to be more effective in the classroom. Furthermore, the structure of PEPTYC fostered local, regional and national networking that helped eliminate the isolation many TYC physics faculty suffered. These results triangulate with the data from the surveys that were taken at the beginning of each institute, as previously reported. Participants from the first two PEPTYC programs demonstrated a minimal association with outside organizations while participants from the later programs demonstrated a greater awareness of outside organizations.

Participants also thought that PEPTYC was created to introduce TYC physics teachers to a wealth of new ideas in physics teaching, to encourage TYC physics teachers to form a community to foster continuing innovation and to help TYC physics teachers evolve into grant-seeking physics-education scholars in their own right. According to participants, PEPTYC was created to enhance the quality of physics instruction through providing participants with both specific content knowledge and pedagogical (delivery) techniques. The great majority of interviewees (86%) believed the main goal of PEPTYC was to introduce TYC instructors to the basic tenants of creating an active learning environment in their physics classes. This belief correlated with exposure to current work in the field of physics education researcher by our peers at TYC's and universities. Hence, the general theme of the respondents was the program was designed to introduce the idea of active learning in the classrooms for students and active participation in activities related to teaching for the instructors. The researcher will refer to this as the Active Learning Theme.

<u>Realized Goals of PEPTYC Project</u>

The second question asked, “Now that the project is totally completed, how well are these current intentions being realized? Such as, in what ways is the training you received still being implemented by you in your current classroom, program, and professional activity?”

All the interviewees unanimously agreed that participants still personally carry the spirit of innovation and continuous improvement that PEPTYC encouraged. As stated by one participant (BF41K) "I am constantly re-evaluating what I am doing and trying to incorporate the core concepts of hands-on learning." Participants continue to strive to develop innovative ways to improve instruction. Interviewees stated without prompt, that they continue to attend professional meetings locally and nationally, communicate and interact regularly with their TYC colleagues, especially their PEPTYC peers, and eagerly read about the accomplishments and activities of TYC and other colleagues. This continued personal commitment was consistently demonstrated throughout the entire set of interviews. Participants have continued to contribute ideas and pedagogical strategies with the physics education community well after the project has ended. Participants have sought memberships on committees at the local and national level as well as participated in leadership positions on other professional development projects. Statements like, "I use more technology in the classroom, while I still add in facts from the content area throughout the semester. The lasting effect has been in improving my pedagogy." (MF71W) were typical. Other representative comments include,

> "This program in turn has led me to make numerous presentations at the state and national level, and ones that I hope have impacted a broader audience." (MF31P).

And

> "I have totally revamped my teaching as a result of PEPTYC. Furthermore, I've been a major driver in revamping the physics curriculum

> for our entire district. I've shared my work locally, regionally and nationally." (JM61G).

All but two of the participants interviewed spoke of a significant effect or change that they could directly point to in their teaching. The other two, who happened to be long time teachers, made a common statement,

> "Although I felt I received personal enrichment, making changes was really not something that happened for me because of the PEPTYC program."(JM11L &EM22B).

The researcher will refer to this as the Collegiality Theme.

Effectiveness of Program Methods and Structure

An interview question to solicit the effectiveness of the overall project structure and method asked, "Based upon the costs of these benefits, how well did you feel the project was run and where could changes have been made?" The majority of the participants (85%) stated things like, "Organizationally, it was a well run program and reached a broad range of backgrounds and skill sets pretty effectively." For many of the participants, (65%) the greatest change that could have been made was to include scheduled recreation activities during the sessions; "Perhaps it would have been useful to have a little downtime built in. A couple of half day breaks could have been inserted." (TM41Z). Participants enjoyed the interesting and stimulating people they met, which was also an underlying theme throughout the responses. The ironic thing that a number (35%) of the PEPTYC participants mentioned was the fact that the content presenters sure could have used pedagogical training. Leaders need to make sure that the new physics content is delivered modeling physics education research results, as well. As one participant put it,

> "Sitting through two hour lectures followed by disjointed labs made it seem like the project was saying '*Do what we say, not as we do*.' For me action always speaks louder than words. While we were learning that lecture was one of the least effective strategies for fostering deep learning, our physics content delivery was very traditional." (DM31W).

One participant felt that the participant professional development projects during the institute and over the summer should have been better managed and shared with fellow PEPTYC participants. He noted, "I think I would have pushed for more writing by participants that would lead them to consider publication." (SM71S). The researcher found two themes to refer to. They specifically deal with the importance of downtime and reflection and the importance of modeling and practicing. Hence, the researchers labeled the themes as Downtime and Reflection Theme, and Modeling and Practice Theme.

<u>Benefits from Attending the PEPTYC Program</u>

When the participants were asked "What are some of the specific benefits you gained from the PEPTYC program?" their answers were compared to assertions of active learning and a new found appreciation of active learning techniques.

Interview data showed participants have a life-long devotion to continued professional development and innovation in the classroom. Over 90% of the participants realized an increased knowledge of new pedagogies or the ability to make small adjustments to old and successful pedagogies. They addressed the many opportunities to try out the pedagogies and new instructional equipment while at PEPTYC. They also discussed opportunities to work with colleagues and their enhanced excitement about physics and physics teaching. In 85 % of all participants' responses, a new sense of camaraderie and the ability to meet with fellow physics instructors and discuss mutual concerns was present. For example one person stated,

> "My experience convinced me that I didn't have to teach the way I was taught. I was a successful physics major, so I thrived in the 19th century physics teaching/learning model, but my TYC students aren't me." (BM52E).

He also noted that "Furthermore, I got a research base that allowed me to work with my administration to change my classroom structure and environment." (BM52E). A theme arrived at from the participants statements that were broadly promoted (87%) by individual interviewees was "the ability to change" or "the tools to change", and was consistently found in the transcriptions. The researcher refers to these as the, Tools of Change, and Active Learning Themes.

An example of this type of statement from the interviews is, "I developed the habit of looking at my courses as a dynamic enterprise, always subject to change and improvement." (DM31W). The theme of "Action Rather than Passivity" clearly resounded throughout the data set. "I received further support and time to develop a teaching style that emphasizes peer-instruction and hands-on self discovery methods." (TM61M), one of the interviewed stated. Additionally it was stated,

> "The big payoff was that the program gave me the confidence and wherewithal to totally revamp my teaching. It convinced me that my

old way wasn't working well and it gave me the tools to change, explained why the old ways didn't work and why the new ways can." (SM71S).

Besides this overwhelming support and pleasure in the fact that the PEPTYC program seemed to be a catalyst for change, ultimately the participants agreed that a huge benefit from the program was the network. "A network of individuals which I can bounce ideas off of would be the greatest benefit." (SF51D). Further comments were made regarding the "learning about physics education research" and "continuing to read about the findings from that area" (MF71W), as a true benefit of the PEPTYC program. The theme of "Action Rather than Passivity" appeared to be a major category of benefits from PEPTYC.

Barriers to Success

There are always some barriers to success with any program. When the interviewer asked the following question, "What did you feel were some of the specific barriers that the PEPTYC program needed to address, but weren't accomplished for you?", the following summaries of responses were given. While many (58%) participants answered, "I can't think of any at this time", others identified the need for more time to implement efforts which would help them with the actual implementation of the new ideas in the classroom. The comments spoke to the ability to "share what problems I faced" with other PEPTYC participants. The participants' statements formed a theme referred to by the researcher as Collegiality,

> "I had a realization of the need to stay connected with colleagues and professional organizations and to share/document my efforts for other teachers of introductory physics."(MF31P).

While another stated,

> "At this point something I have become very conscious of is my own resistance to seeing myself as 'merely' a delivery vehicle for a curriculum.
>
> I guess I wish there had been more time spent on other topics." (DM31W).

Two participants (13%), made statements referring to spending less time on "what is wrong with our students", rather, "We need to concentrate on educating the students we have and not spend time yearning for students who are just like us."(JM12O & EM22B). The old mindset that physics students are the only ones who can survive physics instruction despite its unfriendly and sometimes arrogant approach, was prevalent within a subgroup of interviewed participants from this program. The researcher found themes of "Inadequate Time" and the theme "Development of Collegiality" as essential barriers to successful professional development.

Additional Positives from PEPTYC

In an effort to improve the validity of the research, the question "What were the most positive parts of the PEPTYC program for you?" was asked. This question parallels the question "What were the benefits gained from the program" and its responses were richly filled with the ideas of appreciation of new curriculums because of the professional development practice and experience, as well as the ability to change, create, and make modifications to their own courses. This points to the previously stated theme of "Tool of Change."

One person stated, "PEPTYC gave me a life-long devotion to continued professional development and innovation in the classroom. Meeting and spending time with other physics teachers, experiencing an organized survey of many of the new teaching ideas out there, I truly feel like I'm part of a warm, supportive professional learning community." (MF31P). According to one of the participants, "One of the good things about coming back for a second year was that we could see how we each had changed." This participant pronounced that,

> "Participating in PEPTYC started me along the path to where I am now, where lab activities are more inquiry based, significantly more group activities are incorporated into the lecture portion of the course, and I spend considerably less time talking to the whole class than I did before." (JM61G).

Still others stated, "Not surprisingly, I would say student learning has increased" also feeling that "Since student learning is more a result of the things that the students do and less a function of what the teacher does." (SM71S). The researcher found parallels to the theme of "Tools to Change" as well as an appreciation of the "Collegiality" that was gained from sharing new curriculum and ideas.

Negative Responses to the PEPTYC Project

Initially a question related to programmatic negatives was asked as, "barriers to your professional development" while this question asked, "What were the most negative parts of the PEPTYC program for you?". The answer to this question was similar to the responses related to barriers with the exception that a number of the people mentioned the following group of ideas related mostly to the hectic schedule and the time required for a special course. Quoting one interviewed participant, "There were too many hours in one institute day and the meetings of the PEPTYC participants at TX Section meetings were not really as meaningful to me." (TM41Z). While another stated, "The dormitory environment and the ridiculously long days, sometimes the days were very tiring to me." (EM22B). This information also came about within the in-house evaluations that were looked at for the project. Moreover, an interview transcript noted, "I really had, too little gained in the content to make significant program changes." (SF51D). While most participants were not really pointing at direct problems in the program, a theme that was carried throughout the responses seems to be "Inadequate Time".

<u>Influence or Change in Teaching Styles</u>

A direct question was asked during the interviews, "How did the PEPTYC program influence or change your teaching style? Describe your teaching style before the program, after the program, and what it is like today". Conceptual understanding rather than just content presentation was a theme that arose from almost 70% of the responses. For example,

> "I continue to realize the importance of emphasizing the conceptual component. This is not a trade-off for the analytical component. I believe that by enhancing the conceptual component, I improve my student's ability to think analytically."(BF41K).

Further statements such as, "Before PEPTYC, my teaching style was pretty much traditional lecture-lab with demonstrations and a few hands-on inquiries in the lecture time." (TM61M). These were reported as effective means of improving the conceptual views of students. While another participant remarked,

> "As a result of PEPTYC, I now use more MBL activities in all courses using the equipment made available to us at PEPTYC. I am much more

> careful in presenting information and use extensive small group learning environment." (JM12O).

Activity based laboratory sessions rather than traditional verification labs were also a process that led to and was related to change. As seen in this comment:

> "I used to teach three 50 minute lectures per week along with a 150 minute lab (which often were driven by the equipment we had rather than the lecture content of the week). I covered nearly 30 chapters in my intro course and did a dozen or so in my two semester courses." (BM52E).

Traditional university type instructional settings were the normal methods used by 80% of the participants before the PEPTYC project. An interviewed teacher also stated, "I assigned lots of end of chapter homework problems and wrote tough tests. I was very text book driven." (JM11H). However, changes that came out as an affect of the program were then noted in this comment,

> "I no longer lecture. Classes are structured around interactive engagement in a studio environment and we have a project-based focus rather than text-based. There truly is no resemblance between my class structure pre and post-PEPTYC." (DM31W).

As stated previously, integration of "active learning" techniques was also a common practice for the PEPTYC program. This was especially true in the teachers who attended PEPTYC III- VII. This theme of active learning activities dominated (85%) the later groups' answers with such comments as, "Chiefly, I am much more likely today to stop talking and give my students the opportunity to do something during lecture" (JM61G). Clarifying the previous statement, "Pencil and paper tutorial, group work, mini-experiment, instant feedback question with clickers, etc. are all part of my instructor tools." (JM61G). While those interviewed, who had a more "mature" teaching career established, stated things like,

> "I incorporate a little bit of computer labs, I use my computer in lectures, I use techniques of motion diagram, next time questions, warm-up questions, team questions and quizzes…" (JM12O).

All of these types of activities were used to "modify or tweak" what was already being done, while allowing the participants to remain within their "comfort zone". The researcher heard additional comments such as: "I think that it (PEPTYC) improved what I was already doing."(BF41K); and,

> "I was a young teacher that knew that lecture was not the best way to teach physics and the deriving of formulas was of little use. I knew that hands-on methods and MBL worked, so I decided I should use them." (MF71W).

Evidence for change can be seen in comments such as, "But after the PEPTYC program, I do things better." As well as, "I challenge my students more and I am still growing." (MF21M). The responses directed toward what type of change was being made appear under the heading of, "Do I want to teach physics the way that I was taught?" Examples of this include,

> "I used to lecture the entire lecture periods, 'but I was a brilliant lecturer!' and do canned, conformational labs that were only coincidentally related to the lecture. In other words, the way I'd been taught." (DM31W).

With follow-up statements regarding change efforts,

> "Immediately following my first summer with PEPTYC, … I found some MAC computers and scraped up enough supply money to buy Vernier ULI's. That fall, I jumped head-first into Workshop Physics." (DM31W).

Additionally the participant stated,

> "I've revolutionized my curriculum a number of times as I've learned more (from PEPTYC and other TYC programs and some personal research). My most recent (r)evolution was to move to a project-based format." (DM31W).

This participant commented that, during his current sabbatical leave, he would be researching the physics of video games with an underlying objective of finding some usefulness in instruction from them. Accordingly, he stated, "I bet another (r)evolution is in store when I return." (DM31W). This sort of comment continued throughout the collection of data as can be seen in the following quotes,

> "Well, I had already begun to change from strictly lecturing before I participated in PEPTYC. My early teaching career was strictly lecture with a separate lab. After PEPTYC, I moved to a "lecture/lab format" and have that format to this day for the mechanics part of the calculus based course and for both semesters of the trig based course and I had been teaching the second semester of the calculus based course that way also." (TM61M).

Creating the theme "a mindset prepared for change" truly became apparent during this stage of the data analysis.

For some participants, a resistance to "change back to the old ways" was now very apparent,

> "A few years ago, scheduling issues forced me to change my E&M course back to lecture and a separate lab. However, my lecture part of the course is still not strictly lecture (but more than I would like to have)." (JM12O).

For still other teachers, PEPTYC seemed to be about realizing that it was ok to change. This is illustrated in the statement,

> "It validated my sense that what I was trying out in my class was reasonably consistent with physics education research results and that I shouldn't feel compelled to adopt specific materials from others as long as my efforts met some broad criteria for active learning models." (JM61G).

This idea that a participant needed some sort of validation for making a change arose from the data and could be seen within comments like the previous one and the following as well, "PEPTYC in some ways set me free to experiment with my learning environment and gave me a clear and positive context in which to do so." (JM61G). While yet another participant stated,

> "I have been able to institute a large number of changes based on physics education research due to my participation in the PEPTYC Program and have received strong administrative support for the changes due to my participation." (SM71S).

The theme, "validation for making a change" also arose when participants referred to their ability to get administrative support and support from outside funding agencies.

<u>Participant's Reaction to Repeating the Workshop.</u>

If given the opportunity to attend the same or a similarly focused professional development program today, would participants attend the program again? This was a question that the interviewer used to probe the thinking of the 14 interviewed participants. A strong majority of those interviewed (78%) stated, "Absolutely. The benefits far outweigh any disadvantages." (SF51D). They also added that they believed that professional development keeps us active in pursuing improvement. The continuation of learning how to have interaction with colleagues, making follow-up comparisons, and sharing ideas about new teaching strategies was paramount in these discussions. The theme of "Action Rather than Passivity" appeared in these responses once again. Stated by one participant,

> "I want to learn new ways to tweak the pedagogy I presently use as well as having the opportunity to talk /write assessments and evaluating the findings from my assessments." (TM61M).

Another participant stated,

> "I'm involved with implementing some of the same strategies with a local school district; I would strongly consider it, particularly if graduate credit were still available" (SF51D).

While a different participant noted, "Yes, but maybe not in the same role." (SM71S).

Participants considered the program as content important more than anything else,

> "I think that if a program came out that was really good in content I would attend. I think that it would be important to have time to develop

> materials and lessons based on the content learned for use back at my home institution." (SM71S).

But on the other hand, PEPTYC seemed to push some of its attendees to believe in the "Peers Teaching Peers" model. As noted from the interview, "If the program had a focus on teaching pedagogy, I would like to be helping lead it rather than just attending this part." (SM71S). But the "peer learning from a peer" philosophy was deeply embedded from his attendance at PEPTYC according to this statement, "But I also know that I could learn a great deal more from other people and so I would still attend." (SM71S).

The "Peers Teaching Peers" model was also supported with the claim,

> "Absolutely! I feel compelled to give back for all the benefit I've been afforded. During my last PEPTYC involvement I've been able to share some of what I've learned and I hope I've added value to those programs." (JM12O).

In a summarizing statement relating how the PEPTYC participants felt about participation in such an event was a quote about the participant's interactions with peers. "If for nothing more than the ideas that will be generated through the discussion of material with colleagues, I would attend such a life changing event again." (MF31P). Still another reinforced the Dr. Clark "Peer Teaching Peer" vision,

> "I really enjoyed learning from people who I consider as my peers. PEPTYC is a valuable program for peer colleagues to meet and discuss their goals and pedagogies/curricula for like courses." (JM11H).

Professional development for some members of the university teaching system means the sharing of research findings at professional meetings. But according to the interviewed participants, “The PEPTYC program is more of a sharing...a two way communication.” They thought that, “Professional meetings are generally paper presentations and poster sessions with communication primarily from the author to the participant.” (MF21M).

The idea that the PEPTYC workshop promoted different choices for “active learning” was also a strongly present theme during this part of the interviews. For example one person stated,

> “Before the program, I think my teaching style hadn't yet fully formed and although I tried to make my classes learner-centered, I don't think I had a clear conception of what that meant. Since the program, I have a better idea of how and why to use learner-centered instruction, and have since stumbled onto case-based and problem-based learning techniques” (MF71W).

The researcher found additional evidence for the three themes “Peers Teaching Peers”, “Action Rather than Passivity” and “Collegiality” in these responses.

Placing Value on the PEPTYC Program

Although the final question seemed a little redundant to the interviewer, it successfully allowed the 14 participants who were individually interviewed to summarize their feelings about the PEPTYC program. Included in the data below are ideas and thoughts that participants might consider for future program initiatives or might need to address or want to focus on, to make this type of experience the most meaningful one.

A theme of “Needing a Change” was evident in the responses to this question. “I attended the program at a time when I felt like I was really an instructor in need.” (MF31P); “I was in need of a motivational booster as well as in need of a change for my classroom management techniques." (EM22B). Statements like this gave the researcher an indication that two year college instructors look for an opportunity to become better teachers and find these opportunities in professional development programs such as PETPYC. The theme of the "Needing a Change" seemed essential when finding value in the program.

"Is there a method of teaching that is the 'best way'?" Finding an answer to this question, "What is the best method to use when teaching?" focused the researcher on a set of responses that were directed at, "Having the opportunity to find what works best for you as an instructor", or as the previously stated, the project directors philosophy driven theme which stated, PEPTYC is really a "A Program about Choices" The researcher found in the data comparisons comments as noted,

> "I had definitely fallen into the "teach as I had been taught" trap. The program helped me believe that it was ok to be different and it was ok to experiment with the methods that you use to teach your courses by." (BM52E).

These questions seemed to also encompass the feelings of the interviewed participants as is demonstrated by one statement,

> "I really felt that I learned to adapt and innovate by seeing and modifying the materials that the PEPTYC leaders showed me. I have been to other workshops and programs and have yet to find one that actually allows the participant to make choices on how they will implement new ideas like the PEPTYC program did." (BF41K).

Another participant echoed this with the following statement,

> "Most of the modern learning experiences that I have seen pushed a single answer to teaching down your throat. The program leaders were arrogant and didn't really practice what they were trying to teach. I felt this was totally different at the PEPTYC May Institutes." (JM61G).

Each of these statements correspond to then basic premise that a participant in a professional development program call for some level of "Needing a change" if effective processes are to happen.

When looking at both instructional improvement and personal enrichment, it appeared that PEPTYC initiated a dramatic and fundamental change in the way a significant number of participants (78%) conducted their classes. Although anecdotal in nature, many of these instructors were convinced that their students now "learn much more (useful) information" and eventually have better skills than they used to." (TM41Z). Furthermore, according to one instructor, "their interest in and satisfaction with their physics experience has dramatically increased." (SF51D). Participants frequently noted a 90% retention rate in their classes and students' ratings of their overall experience in physics classes at the 80% level, or an "over 8 on a 10 point scale".

For many participants an additional theme of PEPTYC as a "Physics Booster Shot" prevailed after a number of years have passed since participation occurred in their PEPTYC cycle, "PEPTYC gave me the jump start to get going and the sustenance over the years to keep it up." (TM61M). One of the most insightful participants stated, "The early results about barriers to adoption of new curriculum should be given careful thought in the design of future programs." (SM71S). This individual said he had actually been reading and thinking about the PEPTYC program and its effects. He told the researcher that he was planning on submitting his own proposal for a similar type of activity. Hence he stated,

> "Future activities might address how we at the TYC institution can engage in teacher prep activities, helping to train adjunct faculty and new faculty in physics at TYCs and writing about our activities and experiences in the classroom for publication." (SM71S).

While another interviewed participant noted that causal inferences related to PEPTYC might be an over generalization and asked the researcher to be careful with interpretation of data. He stated, "Several experiences associated with teaching undergraduate physics meld together into one for me." (DM31W). PEPTYC wasn't the only professional development activity that this and other participants had been involved with. As shown in the statement,

> "The O'kuma-Hieggelke Workshop Physics program, the PEPTYC sessions, TYC 21 and simply attending AAPT meetings, all of these things have framed who I am as a professor today." (DM31W).

While another participant noted, "I was inspired by people like Robert Beck Clark and so many others, to forge ahead and try new things." (JM11H). An additional statement by (MF31P), "One of the best parts of all of these experiences is the people we meet and the connections we make. The only thing I wish is that every physics professor could experience these professional connections." reiterated the point. Furthermore, an interviewee stated,

> "I am especially thoughtful of TYC faculty who presented and organized this program. We really are better as a teaching community than as a

group of individuals. PEPTYC was truly a career changing experience for me." (MF31P).

Still another participant stated that new workshops should address the question of "What do students need?" (SM71S). It seemed as if a small subset of those interviewed were now more interested in "how to reach students" rather than personal enrichment activities. These responses concerning student needs were comparable to additional participants, who commented,

> "I think that it would make sense to have some of the program targeted toward how do we choose and effectively use technologies to help students learn." (MF71W).

They also mentioned new technologies to support learning, "Online/Internet, the use of Clickers and MBL, even future technologies." (TM61M). One interviewee asked, "How do we take better advantage of computers/games/simulation software to get our students more interested in the material?" (DM31W). This participant also asked, "How do we increase the WOW factor and still deliver what students need?" Analysis of this data helped illuminate the following question related to student learning: "What material can be cut so that other material can be covered in more depth?" As well as the question, "How do we help our students be critical users of information?"

Another specific theme that was found during the interview questions was a need to produce workshops that look at the more recent findings of physics education research and how do instructors incorporate those findings into introductory physics courses. The researcher also found a pattern of thought which led him to believe that the "culture of teaching" had changed for these participants. The researcher interprets this as meaning that for many of the participants, their initial purpose for attending the project was "personal improvement" in teaching, while now their feelings were that they had made significant changes in their approaches, and they wanted to understand their "student's views" better, during this point of their career. The researcher calls this theme the "culture of teaching" theme.

Summarizing the various themes that were apparent in the individual interviews would be a difficult task for anybody. Additionally adding themes from the participant surveys and the project reports and secondary data must also be done to triangulate information to assist in some level of validity. The researcher has attempted to group some of these themes into a set of "emerging themes" which will be discussed more broadly in the following sections. After that a summary of any overarching themes, subthemes, and assertions will be provided.

Emerging Themes From Data

Data was gathered from three sources for this project. These included: (1) Pre-existing documentation such as, initial survey responses gathered during May Institutes and project documents, including the original AIP external evaluations, and project reports and outcomes; and (2) e-mail survey, and lastly; (3) in-depth individual interviews. There are many ways to look at these data, especially the individual interview and survey data. The participants were separated naturally into groups based upon the PEPTYC project they were directly associated with. They were also separated into groups via age and years of teaching experience. An effort was made to group these interviews into those who seemed to be searching for a reason to change and those who were just looking for some personal enrichment experiences. When comparing the statements made during the interviews, a number of specific themes became quite evident to the researcher. The ground work for determining these themes was done by exploring the philosophy of the project directors, evaluating the evaluations done by the project directors and the external evaluators, and exploring the results of the surveys and the final reports of experiences that the participants shared with the program directors.

The researcher examined the twelve basic themes that emerged from the individual interviews. While each of the basic questions that were asked by the researcher tended to bring about a specific topic or themes, the lines were blended throughout the analysis. The data is reported based upon the order the questions were asked and not in a filtered reasoned out pattern. After examination of these themes the researcher felt that these twelve basic emergent themes fall under two categories, one being, "What initiates instructors' change?" and two, "How do you create this change culture?" Taking the themes from the interview data and arranging them in the following pattern, assists a reader in seeing theses two questions sifting out themes from the data. The themes have been placed under a specific category and are in a Table 11 below. Additionally, as the reader seeks to understand the researcher's categorization they will see how further themes also were found within the data and are documented within this section. These additional themes are included within this outline of emergent themes.

Table 11: Outline of Emergent Themes from Interviews

Outline of Emergent Themes from Interviews
"What initiates instructors' change?"
A Mindset Prepared for Change
➢ Experienced Teachers find Change Difficult

- Less Experienced Teachers find Change Easier to Make
- Downtime and Reflection Time are Needed
- Additional Time is Needed

"How do you create this change culture?"

Culture of Teaching

- Action Rather than Passivity
- Personal Enrichment
- Reaching Today's Students
- Collegiality
- Peers Teaching Peers
- Validation for Making a Change
    - Tools of Change
    - Designing New Materials or New Courses
    - Modeling and Practice
    - Active Learning
    - Physics Booster Shot
    - Convenience of Time
    - Success is Measured by Usefulness

A Mindset Prepared for Change

One of the specific themes that appeared to the researcher was related to the mindset prepared for change. The researcher found that if the faculty member was already set in their ways, if they had long term experiences that had produced a deeply embedded personal philosophy of teaching, that a great deal of change wasn't evident. As a researcher, this reminded me of the idea that student misconceptions are difficult to address. Once a method has been learned, and it is comfortable, it is quite difficult to create change. Dr. Eric Mazurr, Harvard University Physics professor discussed in his *"Peer Instruction Manual"*(1997), that many instructors seem surprised that their own teaching methods are not as effective as they could be. The inertia of a faculty member who is determined to maintain their own style and not try new and different things is sometimes an extremely difficult thing to overcome.

Experienced Teachers Find Change Difficult

The people who attended the workshop after already teaching a number of years (at least 20 in most cases) almost entirely stated that their teaching style was "basically traditional". For example, one interviewed case stated that,

> "I was doing a few things that would be considered reform methods. But I would say basically traditional. At one time when I first started teaching at the Community College system, I was tending to fall away from that, but when I came to my current school (where I have been nearly 30 years) I was the low man on the totem pole and for lack of time, I fell into the "traditional mode". If you do it for a long time I think it is really hard to shift." (JM11H).

Even after the professional development workshops, the impetus to change was difficult for many of these long term instructors. As a researcher, I really found this to be true with the group of instructors who were a part of the first two May Institutes. These instructors were traditionally taught during their own undergraduate and graduate school experiences and they had really just started to see the physics education reform movement begin to appear as a credible area of physics scholarship. Many of the early participants were interested in making changes that would help their students learn better; however, the changes that were made in their courses and laboratories were done so with caution and thoughtful intent. Based upon the number of different contacts encountered with PEPTYC I and II participants, significant changes were difficult to ascertain.

However, nearly the entire group of original participants discussed their "younger colleagues" back home who took "shared ideas" and implemented them at a much greater level than the early PEPTYC I and II core. This theme was substantiated statistically as well. The demographic records of the participants demonstrated that the first groups of instructors tended to recommend new hires at their institutions to attend later programs. The implementations of these ideas by their younger colleagues made their "senior mentors" feel really good about the progress that their respective departments had made. A specific case (EM22B) discussed his teaching colleague, "There are two of us. He likes some of the stuff that I have done and I think that he has actually taken it further than I have. He is also twenty years younger than I am.". Another Case reminded the researcher that,

> "You know, my colleague, attended PEPTYC a few years after I did and I was really excited how she took the MBL stuff and "ran with it". I know that the students in her class really liked doing those things and I was really pleased that she was able to incorporate the materials from the program at a much deeper level than I." (JM11H).

One interview case also discussed the role of having a partner at his school that was willing to take the lead using some of the computer approaches that were taught. This was verified in a statement related to personal preferences and styles. According to this case,

> "I have taken over the conceptual and algebra based and he has taken over the calculus and astronomy sequence. That's not how it started out. These are the niches that we have fallen into. He has taken a reform approach to the calculus course; it's a lot different than what I do, its more computer aided and computer modeling, which I do very little of. I feel that is ok for him, while mine is more interactive engagement with hands-on equipment. But I think we are both far from traditional lecture approaches that we all seemed to see during our own college experiences." (JM12O).

Also noted;

> "And so I am now going back to some other things. I am trying some project oriented stuff. This is where I was headed towards back in the 70's. It was some of the stuff that came out of Turk, and the Florissant Valley Community College models. I think they were put out by the NSF and published by McGraw Hill. I was shifting my entire model of teaching towards that approach. It was a series of project modules. I am doing a little of that right now, mixed in with using the ranking tasks that I mentioned and some traditional approaches. Like I said before, I am kind of eclectic."

Often times the interviews would lead to a general statement such as; "Right after the program, I contemplated making changes." When asked specifically by the interviewer "Was there change?" Common answers were given such as;

> "Over a period of about 4 years I added an increasing amount of Ranking Tasks and TIPERS (Tasks Inspired by Physics Education Research Studies). I also tried to add open ended questions during lectures, and more guided inquiry labs. I had done a few before that, but this use was really influenced by the workshops. Basically, the emphasis has gradually shifted towards other approaches. I have even included a few discussion kinds of sessions."

The interesting part, that almost always came up via a statement such as the following,

> "I don't exactly do it the way that Dwain described during PEPTYC. You know doing it where he orients his whole course around his discourse management style. I only do it with a few selected topics that way" (TM61M).

One interviewee stated, "I tend to ask questions more, you know, I make the students respond to the questions that I ask. I try not to just tell them the answers when I lecture." (JM11H).

When prompted to answer whether or not doing it like the experts was important, some of the interviewed participants stated things like, "And I have heard that it might be the wrong way to do it, but I don't feel comfortable doing it all that way; so I haven't done it exactly like that." (JM61G). A really consistent pattern among this more mature group of faculty was that, “I tended to make gradual changes testing the water before any type of full emersion into a full scale change.”.

Another response that showed the researcher that some instructors didn’t really have “a change in their mind set” came from case (JM11H). When asked if any changes were made to their teaching style “really not too much” was an answer. The participant stated,

> “I know of some people, they are very into the active learning idea. Some people don’t lecture at all; I still do a lot of it. I have a lot of trouble reconciling that but, I feel like there is a lot of material that I have to cover and if I let them play around with it were not going to get done with what we need to.” (JM11H).

Interestingly, this participant attended two of the PEPTYC cycles, discussed that he really enjoyed meeting people and seeing the demonstrations and has continued to attend local section and national meetings as an outcome of the project. The fact that his mind set remained predominately in the lecture only mode is similar to the group of individuals that had taught for a number of years, making only small adjustments in curricular choices and pedagogical styles. This pattern became more and more evident each time an interview was concluded and examined for themes. The experience a participant had teaching as it related to the willingness to make large scale changes in classroom methods surfaced during this data analysis. The researcher previously referred to this theme related to when in ones’ teaching career are they most willing to change, “The Mindset Prepared for Change” theme.

Less Experienced Teachers Find Change Easier to Make

Another theme that grew out of the comparisons of data is that teachers with relatively little experience in the classroom are much easier to influence and change. An early case stated, “Before the program, I think my teaching style hadn't yet fully-formed (I was a new teacher), although I tried to make my classes learner-centered. I don't think I had a clear conception of what that really meant. Since the program, I have a better idea of how and why to use learner-centered instruction, and have since stumbled onto case-based and problem-based learning techniques (which I like and use when possible).” (MF71W). Often times the purpose that these new teachers saw in the PEPTYC program differed from the more “instructionally mature” set of participants. As stated by one such case “The goals appeared to be to expose & instruct TYC physics teachers on effective, engaging teaching methods, to help them develop a network of peers, and to generally stimulate the desire to improve instruction.” (SM71S). As presented earlier in this chapter, Clark (2003) noted that he thought the number of participants who were using “active learning techniques” during the first years of the program was relatively few while in the later program it was significantly higher. This insight caused the researcher to wonder, “Would experience be a key factor to a participant’s willingness to change?” This question is addressed in the final chapter’s conclusions. It appears from analysis of the data that this experience factor does play a role in change. A conclusion could be drawn that the degree of change for the less experienced faculty appears to be more prominent. Change was more evident in those who were less “set in their ways” before the professional development activities were presented to them. Relatively new faculty were more likely to “totally overhaul” their approaches rather than make small changes and minor adaptations.

The researcher viewed this pattern as a lack of awareness toward current pedagogical issues. This evidence seemed to point to a lower likelihood of participants having the “Mindset Prepared for Change” theme.

Reasons Instructors Attend Professional Development Institutes

People tend to go to professional development workshops for a variety of reasons. These reasons don’t always parallel the objectives of the workshop developers. For example, in asking the questions, “Why did you go to the PEPYTYC professional development institute?” and “What did you expect to bring back from it?”. Participants’ reflections brought forward three specific themes. These themes were personal enrichment, reaching today’s students, and designing new materials or new courses. These three themes are related to the “Downtime and Reflection” theme outlined in Table 11 since the participants tended to mention how there focus pre- and post-PEPTYC changed because of experiential reflections.

Personal Enrichment

When the researcher grouped interviewees into the category of “new teachers” the participants who had less than 10 years of classroom experience, did not mention “personal enrichment” as a goal for their participation in the program. The personal enrichment theme represents statements like, “I was interested in fiber optics. I was trying to increase the content in my second semester course. It sounded like a really neat thing to do and I applied for it.” (TM61M) and “I needed the graduate credit. North Central Accreditation was coming to our school and this credit is needed so that I can be allowed to continue my teaching of physics courses.” (SM71S). The researcher found numerous comments like these throughout the transcriptions. Other comments that were coded as this specific theme included,

> "I was going for some personal, selfish reasons. I felt that I needed some rejuvenation, but I also went into it going with the idea at the time that we were going to develop a laser optics program." (JM61G).

Another participant said, "It was a lot of working hours to get 3 hours of graduate credit, but I needed that to advance professionally on the pay scale." (SF51D). When asked the question, "What kind of impact did PEPYTC have on your students?", one member of the interview group responded, " I didn't really see a lot. But for me it was personally enriching." (JM11H). The researcher followed this up by asking whether personal enrichment was the goal and the participant stated,

> "I really enjoyed being able to learn a lot of stuff there. Dr. Clark did an excellent job explaining stuff and showing us his teaching style and I really enjoyed that. I really picked up a lot from him. He is a great lecturer." (JM11H).

Reaching Today's Students

An example of the theme "Reaching Today's Students", is represented by this interview case,

> "My purpose for attending the PEPTYC institute was to upgrade physics pedagogy that I use in my classroom. I think seeing the changes that are occurring throughout the country have been important to me as a teacher. I needed to be introduced to the Physics Education Research and the results

and consequences of such, so that I could become a better teacher and my students could become better learners.” (BM52E)

Another case stated,

> “I was excited when I was able to work out the details with my administration and other members of my department so that I could participate in the program. I was even more excited when I was accepted into the program as I could see that my participation in such a program could affect the student learning that goes on in my classroom.” (JM61G).

Another participant said,

> “I was a novice teacher when I started the program, so I did not really have a style of my own prior to PEPTYC. Now, I do very little lecturing and instead have the students actively learn with labs and worksheets. I feel confident that this is a better method of teaching than what I was exposed to as an undergraduate student.” (MF71W).

<u>Designing New Materials or New Courses</u>

A third theme arose from the group of instructors who made serious efforts and significant changes to their approaches to teaching. This theme “Designing New Materials or New Courses”, was an important part of the instructional process. One case stated,

> “PEPTYC validated my sense that what I was trying out in my class was reasonably consistent with Physics Education Research and its findings. I shouldn't feel compelled to strictly adopt specific materials from others as

> long as my efforts met some broad criteria for active learning models. I was capable of creating materials that fit my classroom needs." (BM52E).

Another case also noted, "PEPTYC in some ways set me free to experiment with my learning environment and gave me a clear and positive context in which to do so." (DM31W). When asked about development of curriculum for future projects, one case said,

> "I would love to participate in such a process. No question. I was very conscious that for many other participants it was their first experience with an environment that seriously supported their desire to be more effective in their teaching. I came from a campus environment that has always supported me in exploring how to teach more effectively and foster risk taking in the teaching environment. This probably made the PEPTYC content less crucial for me; but meeting many of the players in this field and understanding more clearly that I could make a real contribution to the overall discussion was very empowering." (BM52E).

The researcher found that a significant number of the interviews he conducted included a set of instructors who really felt that creating materials rather than strictly adopting entire packages was essential to finding their place in the physics instructional world. Another case stated the biggest benefits from the project came as a result of the "Increased knowledge of new pedagogies or making tweaks to old and successful pedagogies, having opportunities to try out the pedagogies and new instructional equipment, as well as the opportunities to work with colleagues"

(BF41K). To this instructor and to others as well, all of these activities lead to the revitalization and an enhanced excitement about physics and physics teaching. As this case stated, the project was a "timely reminder of why I chose to teach physics." (MF31P).

Professional Development must be Convenient

Another theme that arose is the "Convenience of Time" theme. This theme grew from statements where a number of participants, and the leadership team themselves, felt that they had found a program that provided professional development credit at a time in their professional lives that fit into their life schedule most conveniently. This was done by providing the opportunities right at the end of most semesters, into the last few weeks of May.

For many, but not all participants, the end of a semester provided a small overlap where professional development could be obtained both efficiently and effectively. Clark (2003) noted, "If you tried to do it over the middle of the summer it keeps you away from family." Our evaluation reports told us "It appears to be most advantageous if you do it at this time." Since most graduate credit is offered by a graduate institution, Monday, Wednesday and Friday at 9:00 in the morning during the fall and spring semester, it would be a very awkward time for two year college faculty members to attend those classes to get graduate credit, or professional development. This theme arose from not only the leadership teams philosophy but also the participants who made claims such as, "I really didn't like being away from home for two weeks in May, but I figured there wasn't really a better time for us, or A&M." (JM11H).

Although "Convenience of Time" is the highlight theme in this section, in many ways it parallels the previously mentioned "Inadequate Time" theme, since professional development requires a time frame that provides both convenience and adequacy of time. The researcher grouped the "Inadequate Time" theme with the question of "What initiates instructors change?" question because it appears that it might be a barrier to successful change initiatives.

The Leadership's View of PEPTYC

Furthermore, after additional analysis of initial interview excerpts with the program founder Robert Beck Clark, the researcher found and added a theme related to what success means to the leadership team. This theme measures the program success via the participant's view of its applicable usefulness. This theme "Success is Measured by Usefulness" also assisted the PEPTYC program in developing a culture for teaching change.

Success is Measured by Usefulness

According to Robert Beck Clark (2003), the greatest success of the program was the fact that most of the program was designed by two-year faculty members for two year faculty members and therefore, "What was presented, by a large extent, was useful to the participants.". They found ways to use and implement the materials into their programs at home. Clark noted, "Often times the bigger the information gap between the presenters and the participants, the more likely things are neither interesting nor relevant to the people who are involved.". Clark proclaimed that PEPTYC had a close enough match so its participants could find ways to use the ideas, materials, and curricular ideas in their own instruction.

Clark viewed the pedagogical aspects of the project as the most successful part of the program. While the frontiers of modern physics topic, he deemed as "a little less successful". Clark saw success in "teaching how to teach" even without breaking into the modern physics program.

Overarching Research Theme, Subthemes, and Assertions

After triangulating all data, the researcher generated two overarching themes with five sub themes and multiple related assertions for each subtheme. In the most general terms, themes are patterns that emerge from the data and subthemes are the parts that make up the larger themes. Assertions are statement used to explain or justify the themes and subthemes. Assertions are based on evidence directly contained in the data.

Overarching Research Themes

Two-year college physics faculty were committed to improving themselves, and their teaching and learning through a collaborative professional development program which provided a plethora of choices and experiences within both a content based and contextually driven program. These experiences also modeled methodologically and pedagogically driven approaches to teaching physics. The program was a transforming experience for these teachers in higher education. The first overarching research theme is commitment for improvement of two year college faculty through collaboration. It is through these collaborative efforts that two-year college instructors form a mindset that is prepared for change.

The parallels to good practices in professional development was the second overarching theme for the PETPYC project. This theme tended to provide the leadership of the PEPTYC project with a plan to provide a culture for better physics teaching at the two-year college level. As stated previous in the literature research, there were nine basic practices that could assist professional development designers create an effective and efficient program. These practices seem to be consistent in some level throughout the PETYC program. An example is ‘teacher involvement’, the peer to peer instructional mode laid the foundations for this from the start of the program. Also ‘content in context’ was one third of the entire program. The modern physics topical lectures and laboratory activities were a specific example of this project strategy that exemplified good professional development practices. Within each of the May Institutes, a ‘sense of continuity’, the third parallel to good practice, was displayed. Each semester’s physics content was connected with the modern physics applications and the overarching theme of modeling pedagogical approaches.

The fourth and fifth parallels were a ‘sense of collegiality’ and ‘a team building emphasis’, which was very easy to see in the data patterns. This was almost carried out beyond reason since roommates were selected and stayed together in the dorms, and later, hotels. Group activities abounded in the project. Teamwork was a motivation for most labs and curriculum writing experiences too. The sixth parallel is the reflective practice. Earlier PEPTYC groups requested more time for reflection and the leadership team began providing more and more of these opportunities, not just outside of the classroom, but within the heart of the program as well.

The seventh parallel, ‘a conceptual approach’ also is supported by physics education research results, which has been promoting the ideas of a conceptual approach to physics instruction. The PEPTYC leadership team followed this approach completely. Instructional decisions that are based upon a conceptual basis seem to have a strong research foundation and hence were featured throughout the project. The eighth parallel is a workshop experience which is based on 'principles of adult learning'. Adult learners need the respect of their peers and the leadership instructional staff to maintain a good organized program. Valuing the opinions of all participants also promoted this emphasis on adult learners which is a component of a good professional development. The ninth component is the 'inclusion of an evaluation component' in the professional development program. This was done internally and externally, and now is being done as a dissertation research project. Evaluation continues to be an activity that must be included as a part of any successful professional development program. This secondary overarching theme highlights PEPTYC as a professional development model which parallels good professional development practices. This theme is evident in nearly every category examined.

Five subthemes emerged from the data each with assertions for a totality of the findings. The five subthemes include the following, (1) an identifiable culture, (2) curriculum dissemination, (3) epistemological views, (4) professional development model, and (5) identifying program stressors.

Subtheme 1.

Identifiable Culture: The participants of the various PEPTYC programs have an identifiable culture. This culture is based upon similarly held beliefs, commitments, expectations, and values for the work they do. This culture is related to the concepts of collaboration, teaching students through active learning techniques, measuring student learning with appropriate assessment tools, fostering an ethic of care, and the climate of their collaboration.

Assertions:

1a. There is a commitment among PEPTYC participants to improve student learning by improving the practice of their teaching through professional development experiences and informed choices. This assertion follows from the previous stated themes related to PEPTYC introducing active learning to its participants as well as introducing them to various other tools of change.

1b. PEPTYC participants perceive themselves as professional teachers who are charged with the important work of developing students into the best possible scientific thinkers. Furthermore they are challenged to create a sharing environment for other teachers who are around them. Because of the efforts of the PEPTYC program to meet this expectation, members of this group now tend to model professional approaches to scholarship activities. They also make instructional decisions that are more students centered and knowledge based. This assertion follows from the previous stated themes related to PEPTYC introducing sharing of curriculum and ideas and promoting collegiality to its participants. The PEPTYC program participants modeled and practiced the tools for change and designed new materials and new courses based upon this practice.

1c. PEPTYC participants value and are committed to practice teaching methods that communicate ideas in an efficient and effective way for students. This assertion follows from the previous stated themes related to PEPTYC introducing action rather than passivity to its participants. Part of building a learning culture is the sharing of new ideas and new active learning experiences. The "Physics Booster Shot" played an essential role in creating a culture for the two-year college participants in the PEPTYC program.

<u>Subtheme 2.</u>

Curriculum Dissemination: Through their participation in PEPTYC, members acquired new knowledge about: modern physics content, student perceptions of learning, two year college teaching colleagues, and themselves. Additionally they were exposed to content and curriculum package ideas for active learning based instruction. This curriculum dissemination is related to the concepts of: collaboration, modeling and practice of active learning techniques, creating a mindset prepared for change, and demonstrating a method of validating that need for change.

<u>Assertions:</u>

2a. The participants were exposed to a number of activities that were part of a larger active learning theme. These activities were shared via a peer to peer instructional method which helped to provide the tools for making informed decisions about changes in the participants' professional instructional approach. This assertion follows from the previous stated themes related to PEPTYC introducing the peer to peer instructional method and the importance of modeling and practicing instructional strategies to its participants.

2b. The participants' exposure to these peer led models, demonstrated in an active process, called for participants to implement various new pedagogical approaches. This assertion follows from the previous stated themes related to PEPTYC introducing the ability to change and providing the tools to change to its participants.

<u>Subtheme 3.</u>

Epistemological Views: PEPTYC participants engaged in the critical reflective practice of the program and studied the project leadership's philosophical basis of education. They became empowered to change and transform as individuals and professional teachers. These transformations were perceived by the members to have occurred and are supported by the following assertions.

<u>Assertions:</u>

3a. Through their collaborative work in the PEPTYC process, participants reflected upon the fact that they were given the opportunity to possess a number of new and unique approaches to instruction that basically provided them with evidence and experience to make changes. The participants valued the fact that the program provided them with the tools to change their courses and laboratory activities, a theme introduced and substantiated by previous discussion, and develop new innovative programs within their two year college settings. Although initially the downtime for reflection theme was missing from the initial two cycles of the project, during later cycles, this theme was also supported by the findings in this research. The PEPTYC leadership's philosophy was that success is measured by usefulness; hence the adoption, adaptation, invention and integration of even small parts of the program produced a degree of change.

3b. Through the interaction in the PEPTYC process, the faculty participants felt that they were not isolated from the single path that had led them to this point in their careers. This enabled them to engage in an action based change mode, rather than maintaining a passivity style to their teaching careers. The belief that if peers are doing these types of active learning activities and they are working for them, its ok to change, was a perception that arose from the fellowship, reflection, and relationships that were produced at the program. Collegiality blended a number of themes that were isolated from previously discussed data.

3c. Participants perceived that after their interactions within the PEPTYC program, they had the necessary tools and training to make either small or significant changes to their instructional approaches, classroom management styles, and curricular development. These interactions strengthened their apparent new found ability to make beneficial, informed instructional changes. These assertions were drawn from the themes found in the synthesized interview data.

3d. Participants felt they had seen a visionary approach to instruction that was both informed and objective. This approach enhanced their ability to think for themselves and make informed choices based upon their values and experiences. This process of keeping the participants minds door open toward change was an underlying theme discussed previously and hence provided the participants with an avenue for creating a mindset prepare for their instructional change.

3e. In terms of validation for change, the PEPTYC participants perceived themselves as more confident and open to taking risks and more open to try new and different things. They became more open to practice active learning and act in a supportive way when working with others outside of the PEPTYC project. A joint assertion based upon the theme of collegiately and active learning validates this assertion.

Subtheme 4.

Professional Development Model: The PEPTYC Professional Development Model was based upon an approach that empowered peers to share knowledge, expertise, and experiences with their own peers. It provided the participants with an ability to develop a sense of mutual trust and respect for each other. It allowed them to openly share and support one another through discourse. It is the discourse that is identified as a reflective practice recursive in nature and reciprocated among the group.

<u>Assertions:</u>

4a. PEPTYC participants identified their perceived roles and the roles they perceived their colleagues to hold as being fluid and rotating among themselves. They participated in instructional roles as well as learner based roles. During a professional development program like PEPTYC these roles change, especially when various participants step forward to assist in meeting the dependent needs of others. This has foundations in the theme of peers teaching peers as a methodology.

4b. PEPTYC leadership shared responsibility of instruction with their peer participants, carrying out work related tasks to meet the needs of all the membership within the group. This collegiality provided opportunity within the framework for sharing and dialoging, collaboration and the elimination of isolation from a usually isolated group. This also has its foundations from the overarching theme of creating a program that parallels good professional development practices.

4c. PEPTYC participants found a model of peer instruction that was the center focus for the PEPTYC project. It was an experience generally dominated by activity-based learning experiences, rather than filled with "professorial droning." The professional development model included multiple instructors who were on the participants same academic plane, fulfilling a need to expand beyond isolation in the two-year college physics teaching community.

4d. PEPTYC participants who wanted professional enrichment, a.k.a. "A physics booster shot", found ample opportunity to enrich their content and pedagogical knowledge during the PEPTYC projects' May Institutes and follow-ups. These practices were consistent throughout the seven cycles of the program with reported enrichment from all phases. The "Physics Booster Shot" was an emergent theme that was substantiated by data from the interviews conducted by the researcher.

4e. Through their collaborative work, the leadership provided a series of activities that promoted choices. These choices became informed choices that were supported by the peer interactions and follow up activities during both scholarly and informal methods. The theme that emerged from the interview data labeled as a culture of teaching substantiates this assertion.

4f. The PEPTYC project format facilitated the development of collegiality. Many of the learning activities placed the participants into groups for collaboration and collegiality which also was significant in creating a culture for change, an assertion from a previous subtheme.

4g. While participants questioned the lack of activity downtime, they seemed to appreciate any additional reflection time during the May Institutes. This reflection time, while not initially a significant part of the scheduling, became an important issue as the program progressed. Participants began suggesting this for future programs and stated they needed the reflective periods to absorb and apply their new knowledge. This emerging theme of downtime for reflection correlates to this assertion.

Subtheme 5.

Identified Program Stressors: The PEPTYC professional development model wasn't without negatives and barriers. Participants identified actual and potential stressors as the negative impacts of the PEPTYC program process as felt by many participating members. These stressors are considered a subtheme for the research because they did affect the final outcomes for the professional development project.

<u>Assertions:</u>

5a. Stressors of actual nature were real and did occur, whereas stressors of a potential nature were anticipated to occur. The experience of long hours of working, minimal revitalization time, and long periods of time away from home that weren't the most convenient tended to increase discontent toward future attendance. The theme of downtime and reflection supports this assertion and was based upon evidence found directly in the data.

5b. Participants had perceived stressors related to time. These included the amount of time needed to practice a specific process or the amount of time needed to work on the PEPTYC program and make changes to one's classroom content, curriculum, or management techniques. They also included logistics, pertaining to how to manage student numbers in classrooms and students' perceptions in a specific classroom situation. The analysis of barriers affecting change supports this assertion and was based upon evidence found directly in the data.

CHAPTER 5: Results and Conclusions

Overview

This chapter will contain the conclusions drawn from the case study produced during this research. The connections between research subthemes and the conceptual framework, discussions of implications for future practice, and suggestions for future research are also shared. Additionally, recommendations for the two-year college teaching profession and professional development education community will be made. Finally, suggestions for further study will be offered.

Reflection on the Process

To gain the understanding of participant's responses to the PEPTYC professional development program in this study the researcher used qualitative methods. The interviews he employed were designed to address the research question from the perspective of grounded understanding. The same approach was followed in the data analysis procedure. The research timeline was followed fairly linearly. However, interviews themselves were more often conducted as a loosely controlled "dance" following the lead from participant's statements while also adhering to a pre-defined protocol. The data gathered began to make more and more sense, as the interviews progressed and as common themes started to emerge. During the interviews, the researcher perceived that most subjects seemed very interested in talking about their teaching practices. Sharing information with the researcher often times evolved into conversations about teaching at the two-year college in a physics department, rather that a strictly controlled interview process. Gradually the researcher realized that there are some explanations given by the participants for what they did after the PEPTYC program, which seemed outside the typical responses. These outlying explanations were beyond the themes that were derived by the researcher, but they are justifiable courses of action. From these participants' perspectives, this would also be valid justification of the program outcomes. The researcher notes that not all cases will come up with the same style of solution to the same objectives, and patterns were only a generalization from a small sample set. Altogether, the research was a thought-provoking, challenging and enjoyable experience.

Strengths, Limitations and Goals of this Study

Limitations of the Study

Describing the intellectual and methodological ground of a study implies that ground exists beyond that staked out for the study. Describing such ground is called delineating the limitations of the study. Six such limitations were identified:

1. Employment of a case study methodology precludes generalization of the findings.
2. The researcher is the primary data gathering instrument; thus, the conduct and products of the research are dependent on his skills, habits of mind, and ability to avoid biases.
3. Effects on participants who have received other exposure to this curricular material are not part of the study.
4. A limited number of participants were interviewed.
5. The participants supplied self reported data only.

6. Data includes memories of participants from an event that occurred up to 15 years ago.

<u>Strengths of the Study</u>

The study was done in a qualitative method and looked at three basic data sources. The sources of data for this study ultimately included the following:

1. Analysis of the preexisting documentation, which included all seven prior surveys of the May Institutes done internally by the leadership team, external evaluations done by the American Institute of Physics, various program documentations and additional project outcomes.
2. Results from an e-mail survey which was distributed to all participants in every PEPYTC program who were still living or working as teaching professionals.
3. And finally, a set of 14 in-depth interviews with selected participants from each of the various seven cycles of the PEPTYC program.

The final two data sets were acquired after the PEPTYC program was officially completed. The researcher specifically conducted this data gathering for this study. The initial set of materials was gathered by Tom O'kuma, Robert Beck Clark and the American Institute of Physics during the 15 year duration of the project. The reports and preexisting documents were made available to the researcher after the project was completed. The triangulation of data between these threes sources helps minimize bias which could have appeared if the researcher would have been the sole collector of the three data sources and thereby enhances the validity of the results. Multiple comparisons were made across multiple data sets which enabled the researcher to obtain a relatively large degree of reliability based upon the triangulation of these various data sources. This triangulation was done by looking for common results within the three major data sets. The first one, preexisting documentation, which actually could be broken neatly into at least five basic data subsets, the second one, which had a survey response factor of approximately 75%, and the third one, which included 14 specifically chosen participants based upon age, gender, teaching experience, participation in a specific PETPYC cycle, and a stratification that matched the combined program demographic statistics quite well. An additional verification of some conclusions drawn from data from another study, (Dancy & Henderson, 2008) of a similar design leads to additional strength and validity in the conclusions that were drawn about this project.

Research Goals

A critical aspect of the researcher's own research goals were the non-evaluative, interpretive approach: The researcher felt that the description of teachers' involvement in this encounter with the information from the PEPTYC project must be informed from start to finish by their own meanings. Unlike much of the research investigating the efforts to introduce reforms into classrooms, the researcher's goals did not include an evaluation of student outcomes; rather, the focus was on the teachers (project participants). The researcher wanted to get close enough to a few PEPTYC participants to document the details of their change efforts and to share on-going impressions of learning, student interactions, and thoughts behind the initial use of their newly acquired and available resources. The researcher did hope that by "tagging along" as an uncritical participant, instructional leader and natural observer of their start-up activities and ongoing implementation of project disseminated materials, knowledge of the nature of how teachers enact changes and other innovation into their practice, would be gained.

In this case, the change effort was self-initiated not imposed top-down. Yet, the researcher assumed that in order to fulfill the goals of the PEPTYC project, especially to integrate its philosophies into the curriculum, "Some, if not significant changes, would be required.". As the researcher, assumptions were made as to my ability to observe any changes in the participants teaching style, classroom physical arrangement and management approach, as a function of their reported usage within their classes. If this research role was managed well, a belief by the researcher was that the participants would share their thoughts and ideas about using these instructional ideas and its purported promise for education.

The Research Questions

A clear picture of the process behind creating the PEPTYC program was painted in this research. The researcher looked at techniques the program directors applied to assist in the dissemination of Physics Education Research based curriculum to its participants. The researcher tried to understand the current paradigm in which curriculum dissemination occurs. Hence, one purpose of this research was to understand the PEPTYC program as deeply as possible, including the specific underpinnings that led to its effectiveness and ineffectiveness in training physics teachers at the two-year college level. Ultimately, the researcher developed a rich description that allows readers to determine if and why PEPTYC is a model professional development methodology for the dissemination of curriculum materials and pedagogical practices that would led to instructional change.

The researcher used a qualitative approach to collect and analyze data and used the tradition of inquiry know as a case study approach. Using the case study tradition of inquiry, the researcher was able to focus on a thick description of the participants and the activities in which they were immersed. The researcher looked for the formation of themes from the evidence that was collected from three major sources including pre-existing documentation, such as project reports, project evaluations and internal and external surveys, a post project researcher designed e-mail survey and 14 individual in-depth interviews. He attempted to make the major focus of this project a search for the answer to the following overarching questions:

1. In what ways did PEPTYC affect or change the teachers who participated in the program?
2. What were the effective and ineffective practices of PEPTYC that led to these changes in the teachers who participated in the program?

Final Analysis: Answers to the Research Questions

Throughout the data collection period, the researcher scrutinized the transcripts of interviews and any of his additional notes to identify themes, strands, patterns, and trends occurring within and between the various cases. As the study progressed, tentative relationships were presented to subjects for scrutiny, verification, validation, and modification. The major themes identified in chapter 4, have led to this final analysis: "Answers to the research questions".

1. In what ways did PEPTYC affect or change the teachers who participated in the program?

The following list of themes were found related to the affect or change in teachers who participated in the program. These themes have been discussed throughout Chapter 4, and a brief statement related to these themes is provided as a guide to assist in the understanding of their meaning and are listed below:

1. Personal Enrichment--The main focus and reason for many of the initial PEPTYC participants' attendance in the professional development project.
2. A "revolution" or steps towards the "evolution"--Becoming a new teacher, changing their philosophy, teaching styles, classroom management methods, and use of computers as tools to teach science.
3. A Mindset Prepared to Change-- Reasons for attending PEPTYC were based on student improvement rather than personal improvement. Efforts to find methods to assist students in becoming better learners, rather than just learning more physics were noted.
4. Reaching Today's Students- The research data points out the fact that becoming a more "active and activity based" instructor is more in tune with the needs of today's physics students.
5. Design New Materials for New or Existing Courses--instructors from all the PEPTYC phases felt more comfortable in their efforts to understand the philosophy and research foundation behind curriculum innovations.
6. Peers Teaching Peers--Whether watching a great lecturer, or a peer demonstrate, participants found out from other teachers how to teach. The PEPTYC participants feel as if they were a part of a larger teaching fraternity

which had a common goal of improving the teaching of physics at the two-year college level.

7. Collegiality—A shared approach to teaching and learning was promoted as building relationships throughout the PEPTYC program.
8. Convenience of Time participants used their time following their spring semesters to reflect upon their courses creating the habit of using the post-semester block of time for personal at-home based professional development.

2. What were the effective and ineffective practices of PEPTYC that lead to these changes in the teachers who participated in the program?

The following list shows the themes that were found to be effective practices leading to changes in teachers who participated in the program. These themes have been discussed throughout Chapter 4, and a brief statement of how these themes paralleled similar ideas are provided as guides to assist in the understanding of their meaning and are listed below:

1. Peers Teaching Peers – A joint effort of collaboration between teaching peers and research experts
2. Active Learning – Providing an opportunity to learn content in context, with an emphasis on modeling and practice of these newly shown skills.
3. A Program of Making Choices – Supplying the background information on materials and the research conclusions from the Physic Education Research community.

4. Collegiality – Creating shared collegial experiences which included the expansion of participants' network of peer teachers, mentors, and friends to assist in implementation of change.
5. Creating a Disciplinary Culture – Realizing that teaching change is evolutionary by creating the environment and allowing for the time and practice for it to evolve.
6. Experienced Teachers Find Change Difficult –Differences in experiences must be considered when creating models promoting change.
7. Less Experienced Teachers Find Change Easier to Make – Less inertia allows for a greater degree of flexibility and possibly a more efficient change evolution.

After analysis of all the data, the researcher really had difficulty finding too many ineffective practices in the conclusions that were drawn. The only real ineffective practices fell within the parameters of too much time commitment is needed because change takes a lot of effort. In addition, professional development programs need to practice the pedagogical strategies they are promoting and teaching. Program directors must model their methods throughout the entire program. And in the end, even the best efforts cannot change everybody. These conclusions are not revolutionary since most people believe that change takes time and effort, but they are reasonable to defend. Change needs to be modeled, and anyone who thinks for themselves would not always want to accept change.

Conclusions

<u>Opportunities for TYC Professional Development</u>

Numerous professional development programs have been created and workshops and activities have been presented in an effort to make changes in our current educational setting. One such effort has been Dr. Robert Beck Clark's, and Thomas L. O'kuma's fifteen year collaborative professional development project. The researcher conducted this research in an effort to understand the effectiveness of this cooperation between a major research university professor (Dr. Robert Beck Clark, Texas A&M), and a group of two year college faculty (Led by Thomas L. O'kuma, Lee College). However, it is but another step in the long path that this researcher, as well as other leaders in the two-year college physics community, have undertaken to highlight the value of two-year college physics education professional development opportunities to the larger science and science education communities. Although physics education researchers are extremely excited and proud of their efforts, it is still a problem that the profession as a whole faces a public perception that the most exciting scientific developments are likely to occur in fields other than physics. Physics, as a topic in general, has a stigma of difficulty placed on it. Hence, it is increasingly disconnected from societal needs and federal priorities. The result is that potential students do not see the connection between physics and their daily lives and future careers. Funding agencies haven't always seen the cost benefit ratio for professional development programs with the same eyes as the participants in such programs.

According to Dr. Robert Beck Clark, project coordinator,

> "We had been conducting similar programs for high school teachers since the early 1970's. The programs were for high school science teachers, occurring every summer. When the national science foundation in the

> early 1980's re-funded the teacher enhancement programs, we (Texas A&M Physics Department) received one of the early grants for our physics teacher development program and called it PEP, (Physics Enhancement Project). PEP was essentially the same as the PTRA (Physics Teaching Resource Agents) program" (Clark 2003).

PTRA is an American Association of Physics Teachers program which targets high school teachers who become members in the PTRA program and then are looked upon as teacher resources for other physics teachers. Clark also claims to be fortunate enough to get the PEPTYC grants throughout the 1990's, stating; "Our success from the previous grants was significant in securing the PEPTYC funding" (Clark 2003).

New Idea: Professional Development for Two-year Colleges

The PEPTYC program was actually a fresh new model of a professional development program that appeared to be years ahead of its time. Clark (2003) commented during an interview conducted by the researcher at the last PEPTYC May Institute that, "Programs specifically designed for two-year college physics teachers were just coffee break discussion topics before 1990." In 1990 when PEPTYC first came onto the scene, before the publication and release of the *National Science Education Standards* (National Research Council, 1996), it was a professional development program that was being created by visionary leaders, who had participated in many conversations with other teaching physicists about the improvement of physics education at all levels. "Discussions of the training of physics teachers at the two-year colleges were really fostered with the participation of people like Tom O'kuma, Marybeth Monroe, and Jack Hein during our Texas Section Meetings in the mid 1980's" Clark (2003) noted. The program sought and received its initial funding from the National Science Foundation and finished its final year, its 15th year of funding, late in 2004. According to its founders, Clark and O'kuma, the leadership team of PEPTYC, had adapted and changed the program after each funding cycle and PEPTYC continued to be labeled by the National Science Foundation as a model program for professional development, especially in the area of cooperation between two-year and four-year colleges. The following five highlighted areas are ideas that made PEPTYC unique and provided the specific targeted opportunities in professional development for two year college physics instructors.

Peers Teaching Peers

One essential feature of the PEPTYC project, in which this research was conducted upon, was the utilization of experienced outstanding two-year college physics faculty members who have been recognized for their success and innovations as two-year college physics teachers. These instructors were what Dr. Clark called his "Peers Teaching Peers" collaboration. According to Robert Beck Clark (2003),

> "Tom O'kuma, was a tremendous help in recognizing these people, They served as instructors during both the May Institute phase of the program and the follow-up sessions of the program during the academic year."

Clark also attributes the use of colleagues as instructors to the PEP and PTRA programs,

> "We called it back then "Peer Instruction", not Eric Mazur's (think, pair, share) active learning classroom approach, Peer Instruction (Mazur, 1992) where the majority of the teacher training was done by high school teachers to high school teachers, hence peer instruction, teaching done by peers.".

These same PEPTYC instructors were available on a continual basis during the project for consultation and advice through e-mail and telephone, providing support for other participants of the project. This fundamental theme (Peers Teaching Peers) appeared to appeal to the members of the two-year college teaching community. It seems to align itself with a number of the nine components of effective professional development, as advocated by Kraft (1998), including having one significant commonality, that of collaboration. The process of collaboration was a major component of the PEPTYC professional development model according to Clark (2003), "We thought that the teachers teaching teachers model was an excellent process during the PTRA and PEP programs, and we went with it." (Clark, 2003).

Learning Content in Context

This two-year college teaching resource was coupled with modern physics content resources and then technical and applied quantum optics research foundational information in the form of outstanding research physicists who were recognized for excellence in their fields. The presentation of the modern physics topics by research physicists in conjunction with their supervision of hands-on experience provided the basis for the participants to learn innovative ways to teach topics of modern physics and quantum optics in their introductory physics classes. This practice of learning content in context is another example of effective professional development. (Kraft, 1998). The collaboration with the research scientists seemed to provide the emphasis for this approach.

Making Informed Choices

This project was designed to serve as a model of a cooperative working relationship between university physics faculty members and groups of outstanding two-year college physics faculty members to provide valuable in-service and professional training for other two-year college physics faculty members across the country. It also included the introduction of various physics curricula that have been designed by researchers in physics education. The dissemination of this research based curriculum was not done to force change upon the participants, but rather was done in an effort to get the participants to "think and make appropriate choices" for their own styles and own teaching scenarios. The theme of "A Program about Choices" emerged from analysis of nearly every piece of data in this research. For participants, being allowed to make these informed choices was essential.

Shared Collegial Experiences

Another benefit of the program was the creation and extension of a national network of two-year college physics faculty members to serve as leaders in the enhancement of undergraduate physics education at two-year colleges throughout the United States. The experience of regularly living and working together as colleagues in a residential campus setting over a two year period led to the development of strong, long-term links and eventually a national leadership network. This linkage can be seen in the documented evidence that has shown that participants began "sharing" information at local, regional and national meetings, well after the final credit requirements were finished. This sense of collegiality is another component of good professional development practices (Kraft, 1998) and is a theme that was echoed throughout the responses from the interviewed participants. The theme is noted as "Collegiality" which encompasses the concept of shared collegial experiences and shared scholarly knowledge. This effort assisted in making the PEPTYC program effective and successful.

A Call for Scholarship in a Two-year College Setting

Scholarly activity is now the benchmark for academic success at the two-year college according to the American Association of Physics Teachers Two Year College Physics Program Guidelines (2002). But this is a significant change, whereas scholarly publications and presentations have long been used as a benchmark for professors at four-year academic institutions. Until recently, the two-year college physics teaching faculty has documented their success by tracking students' success at their transfer institutions. This tracking of students was done by examining grade point averages, analysis of successful transfer and articulation, or mostly by anecdotal evidence such as word-of-mouth and personal recognition by students to their two-year college instructors, not through scholarly publications or talks at physics teachers' meetings. "The mission of a two-year college physics teacher was preparatory education for transfer students and for vocational students…" (AAPT TYC Physics Program Guidelines, P.34). This mission changed and recent thrusts by accreditation agencies (North Central Accreditation Agency, Higher Learning Commission, etc) and reports (e.g. Kent, 2002) have pushed two-year college physics faculty to assess their programs and courses with measurable outcomes. In response, the two-year colleges have tried to validate these calls for scholarly achievements by documenting their activities, as well as participating in the development of a number of assessment instruments. These instruments include rubrics and other measuring devices that are needed to validate standards based education (National Science Education Standards, 1996). The *National Science Education*

Standards express a coherent vision of what it means to be a scientifically literate populace in today's world (National Research Council, 1996).

A Challenge for TYC Professional Development

A major challenge for professional development of TYC physics faculty is the lack of dissemination of curriculum innovations from physics education research. Physics education research appears to be a blooming field with a rapidly growing community of researchers. In the last few decades, physics education research has produced numerous research-based instructional strategies and resources, as well as substantiation that these new strategies and resources can lead to significant improvements in student learning compared to more traditional, lecture-based methodologies (L. C. McDermott & E. F. Redish, 1999). A number of these pedagogical approaches were described, modeled and made available for participant review at the PEPTYC May Institutes. Clark (2003) deemed this his "smorgasbord of educational opportunities" and purposed that these choices were significant if a professional development program would produce change at the two-year college level.

However, despite the significant progress made by the field of physics education research, there is no instructional evidence that physics education research strategies or materials have been incorporated significantly into the average introductory course hosted at a university level institution (Dancy and Henderson, 2008). One of the essential underlying goals of the PEPTYC program was the dissemination of the various curricular pieces created by physics education research to members of the two-year college teaching fraternity. This dissemination of materials was done in a method Dr. Clark described as a "smorgasbord" approach; where exposure to the curriculums was done in an "adaptive or integration" model rather than a purely "adoption based" model. The practice of creating "a mindset prepared for change," which directly led to a continuum of curriculum integration rather than a full scale adoption, as well as the practice of "peers teaching peers" appear to successfully address this dissemination challenge noted in the literature.

Comparison to the Professional Development Literature

Throughout the study, comparison to the literature review was essential in that the researcher continued to examine the data via the eyes of a knowledgeable observer who was trying to see any parallels that might exist in the comparison of the interview data with the general best practices for designing professional development. These characteristics for successful professional development are strongly seen in the PEPTYC professional development experience that the two-year college physics teachers were exposed to. The parallels are remarkably clear. Besides these comparisons, themes that arose were examined by the researcher in complementary studies that have occurred related to topics such as professional development and curriculum dissemination. For example, one specific research article written by Dancy and Henderson (2008) became useful as their analysis of four-year college Physics Education Researcher's curriculum dissemination practices paralleled nicely with the results that were obtained from the PEPTYC professional development project. This article discussed divergent expectations as barriers to the diffusion of innovations via a curriculum dissemination practice overview. An initial summary of five claims that are important to the understanding of the TYC professional development literature and the effectiveness of the PEPTYC project are discussed in the following section.

Creating a Disciplinary Culture

A fundamental claim of current research is that disciplinary cultures are important in shaping faculty behavior. The culture that the PEPTYC participants belong to is actually multifaceted. With some background and strong traditions coming from research science fields, ideas of scholarly “non-teaching” research are still broadly set within their mind frames. Although for most two-year college physics teachers, teaching is traditionally a paramount endeavor. Yet, a yearning for professional disciplinary respect from university colleagues is also a part of the ongoing culture of the two-year college physics teacher. One important theme in the research on educational change is that, although change in teaching practices occurs by individual faculty who work in a particular institution, disciplinary cultures have a significant, if not dominant, impact on faculty behavior (Alpert, 1985). According to this view, changing the way teaching is viewed within the physics community may be the appropriate lever to bring about substantive change in the teaching practices of physics faculty.

The PEPTYC program attempted to do this by introducing a small, but significant portion of TYC physics faculty to a physics education research knowledge base, as well as the pedagogical strategies and materials that have been developed, based on this research. Changing a single faculty member’s views may not be as difficult as changing the views of a group of colleagues, a larger administrative body and especially the larger physics teaching community as a whole. The leadership of the PEPTYC project realized that small effects in the two-year college physics teaching culture that remain present for a number of years after professional development activities were concluded, may hold an impetus for future change. The researcher notes that a large number of two-year college physics instructors come from single member departments and hence, making changes occur is not necessarily a collegial choice.

<u>New Faculty Tend to be Different From Experienced Faculty</u>

A second claim of current research that is relevant to this study, is that newer TYC teaching faculty typically have some difficulties in their initial teaching experiences, mainly because of the isolation issues found at a majority of the two-year colleges, a result of small departments and regional displacement. A need for a strong two-year college physics teacher network for both survival and support is oftentimes significant in new teacher professional development. Gathering together a group of new teachers within the first few years of their teaching experience seems to be an appropriate approach to illicit teaching change.

One reason to develop a professional development program, especially for two-year college physics faculty, was that TYC faculty in many disciplines have been known to have difficulty adapting to their role as strictly teachers and not researchers; especially when those roles include extremely large teaching loads in a single person department (Saroyan & Amundsen, 2004). This is traditionally a role for which most people have not typically been well prepared. Many TYC physics faculty have held teaching assistant appointments in graduate school, worked outside the field, or have been high school teachers. While these activities help prepare them contextually at some level, nothing besides the day to day two-year college teaching experience truly matches the needed skill set for this level of instruction. Some two-year instructors even come from industry and have never taught a course at all. This plethora of backgrounds makes the faculty pool at a two-year college quite unique. Often times, however, few have actually taught a college level course of their own before their first community college level faculty teaching position. Thus, a formative time in the development of an instructor's teaching style occurs early in their career, and professional development programs, like PEPTYC are likely an ideal time for interventions aimed at promoting non-traditional instructional practices (Saroyan & Amundsen, 2004).

Data from the seven cycles of PEPTYC showed that the teachers who were in the first 10 years of their career seemed more likely to adapt their teaching styles and adopt or modify various curriculum innovations that were presented at the various May Institutes.

An alternative view to this idea of relatively new faculty being more open to the ideas of change is that for two-year college faculty on the tenure-track, any departure from traditional time-honored instruction is dangerous, because such changes may require more time than traditional instruction and result in lower student ratings – especially at first (Seymour, 2001). Once, however, their continuing contracts are issued, they tend to be ready to explore more "instructional possibilities" such as those that they were exposed to at PEPTYC. Additional studies of TYC faculty, however, show that it is quite common for new TYC faculty to spend a majority of their time on traditional instructional activities and receive poor student ratings under normal conditions (Sorcinelli & Austin, 1992).

<u>Curriculum Dissemination of Physics Education Research Materials</u>

A third claim of current research that is useful in interpreting the results of this study in relation to the literature relates to the challenges facing the physics community in terms of using innovations from physics educations research. A recent study has been conducted related to the difficulty of disseminating physics education research materials to new faculty at the four-year college level. In this study, Henderson (2008) explain that Boice had studied 77 new tenure-track faculty at two different universities (one with a research emphasis and one with a teaching emphasis) via interviews and observations during their first year (Boice, 1991). By the middle of their first semester, most of the new (university/four year college) faculty reported that lecture preparation dominated their time. Few of the faculty reported teaching skills as depending on anything other than their knowledge of content and clear, enthusiastic presentation. Most described their classes as standard facts-and-principles lecturing and many had no plans for improving their teaching. Most of these faculty received poor student evaluations of their teaching. Their typical reaction in light of these evaluations was to be better organized and to lower standards. These trends continued through all four semesters of the study. Boice (1991) concluded that new faculty typically teach cautiously, defensively, and tend to blame low student ratings on external factors (such as poor students, heavy teaching loads, and invalid rating systems). (Boice (1991) suggests that new faculty would benefit from programs that helped them find ways to increase student participation while at the same time avoiding over preparing facts.

Thus, one opportunity for supporting new faculty is to help them rethink their roles as teachers and to help them use their teaching-related time more effectively. The researcher believes that, quite possibly, the efforts of Tom O'kuma and his two-year college peers assisted in over coming problems stemming from lack of organization and lack of support. Two of the strongest foundations of the PEPTYC program were the high level of organization and the supportive and helpful nature of the instructional staff.

One-time Workshops are not Effective

A fourth claim of current research that is necessary to understand the results of this study in comparison to the literature is that one-time workshop models of professional development are not thought to be highly effective. Although workshop-based professional development is commonly used, there is currently insufficient evidence to claim the effectiveness of this method (Weimer & Lenze, 1991).

In terms of learning theory, workshops tend to be transmission-based and, therefore, just like transmission-based teaching, should not be expected to be highly effective. One review of the faculty development literature concludes that workshops and seminars "are unlikely to produce lasting changes in teacher behavior or lasting impact on students unless participants continue skill practice and receive critical feedback on their efforts." (Levinson-Rose & Menges, 1981, p. 419). A more recent review of professional development activities found that "faculty development benefits from making use of extended interventions, over a full semester, a year, or more." (Emerson & Mosteller, 2000, p. 29). Thus, there is reason to doubt whether a one-time, transmission-oriented workshop can be effective in achieving its goals of promoting instructional change in faculty.

It would appear from this research on the PEPTYC project that a one to two year professional development program based on "peers teaching peers", and making an effort to highlight "collaborative learning experiences", and developing a scholarly community which integrate follow-up activities as well as at-home projects is a more effective approach when promoting instructional change in faculty.

PEPTYC: A Non-Traditional Model

The final claim relating the PEPTYC project to the literature is that PEPTYC provided a very no-traditional model of professional development. The PEPTYC program differs from many typical professional development models cited in the literature in several significant ways:

1. PEPTYC focuses only on two-year college faculty (unlike most professional development which includes faculty from a variety of ranks); within the focus on two-year college faculty.
2. PEPTYC further focuses on faculty from a single discipline (unlike most programs for new faculty which are institution-run and include faculty from a variety of disciplines).
3. PEPTYC presented a wide variety of pedagogical options (unlike many discipline-based professional development workshops that focus on only a single instructional strategy).

Henderson and Dancy (2008) have found that some faculty may be “turned off” by reformers who focus on a single strategy or set of materials. Faculty see these reformers as selling a particular product and as promoting the idea that one type of instruction is appropriate “for all faculties” and in “all situations.” The PEPTYC theme of, “A Program about Choices”, illustrates that PEPTYC was based on multiple informed choices where the curriculum materials that were presented by the experts (two-year college peers) were research based, context enriching topical lectures. The pedagogical information and instructional materials were presented by peers who didn’t have anything to gain personally by adoption, modification, or integration of each of the specific curriculums. Peer presentations promoted adaptation and informed choices and decision making by the participants of the professional development program. As suggested by the literature reviews, one reason for the effectiveness of the PEPTYC project was the way it provided faculty with the motivation and initial knowledge sufficient to allow them to continue learning on their own after the workshop. Follow up activities and the creation of a two-year college culture assisted in that endeavor as well.

Summary of Conclusions

In an effort to condense the various conclusions that could be drawn from this research into a smaller simple subset of descriptive paragraphs, the researcher would begin by stating, PEPTYC was an institute based program that was designed specifically for two-year college physics teachers. These teachers were drawn from a single discipline, physics, which is different than many professional development programs or experiences that are produced for a broader less specialized audience. PEPTYC was a program that was designed to teach instructors about making informed, instructional choices. It was a program that used peer modeling as a basis for its instructional techniques. The credibility of the program came from the interactions of the participants with the peer leadership as well as the theoretical basis for the materials and ideas that were shared. The program was immersive, with multiple exposures to multiple practices in instructional management, and curriculum integration. Underlying the effort to provide opportunity was the effort to create a collaborating network of two-year college scholars. The PEPTYC program also provided numerous follow-up activities and a mentoring program for its participants.

The research done on this professional development experience led to an answer to the question, "What led to the changes in the participants of the PEPTYC project?"

While many of the participants began with a personal enrichment vision, a revolution didn't always hit them from their participation in the activities, more likely an evolution into making small changes occurred. Often times these were based upon participants changing their pre-professional development experience focus, from the "What can I personally gain?" to the, "What can I do to reach my students and help them gain knowledge view". This change occurred when the participants felt comfortable with making changes. This comfort level was brought about by using peers as instructors and allowing instructors to find professional development activities that conveniently fit into their traditional teaching schedule.

Additionally, the research led to an answer to the question, "What were the effective and ineffective practices that lead to change?" It appears from the results of the research that the method of instruction described as "Peers teaching Peers" was quite effective in creating an environment and experience that led to instructor change. By forming collaborations with experts such as the research scientists at Texas A&M, as well as the peer level collaborations with additional two-year college instructors, the PEPTYC program was able to effectively create a disciplinary culture that allowed its participants to believe that making changes in their teaching was acceptable.

The leadership of PEPTYC valued the idea that providing a program about making choices was another aspect of creating a disciplinary culture for change. They also established a process for learning content in a specific context, modern physics. Effective practices of the PEPTYC program included the sharing of collegial experiences. These experiences were highlighted in group activities, morning show and share sessions and were noted in multiple data sources as some of the most effective parts of the program. The PEPTYC program directors realized early on that teaching change is usually more evolutionary than revolutionary. These comments were substantiated by quotes from individual interviewee's and generalized by the program's attempt to create a mindset for teachers to want to and to be able to change.

The most ineffective practice was the fact that initially the PEPTYC leadership team didn't realize that their new faculty participants would tend to be very different from the more mature or experience faculty. This was not a significant fault, rather an oversight on their part, and possibly an outcome directly based upon the available participants who were chosen for the first cycles of the project. Another ineffective practice was having an expectation, initially, that changes could occur more rapidly than actually happened. Not realizing that making changes will take a concentrated effort and time, might have led to a degree of dissatisfaction with the program leadership, however, after the initial pilot program the leadership's acceptance of gradual change became more prevalent. By the end of the program, the underlying philosophy that most instructional change follows a continuum or is evolutionary, rather than revolutionary, abounded.

Implications and Recommendations

In the following section the researcher offers some recommendations, although only speculative in nature, about how future researchers and professional development programs might begin to move in the effective directions as described in the conclusions of this research.

First of all, two year college physics programs are unique. They offer classes to a different cliental than other colleges. Usually two-year colleges don't require faculty scholarship such as research and publication requirements. Many of their programs are run by single department faculty and hence they could be a fertile, but are seldom used as field-testing ground. Professional development for these individuals is best served by creating an environment where “sharing experiences” with peers becomes common practice.

Secondly, when creating an effective environment leadership should provide easily modifiable and accessible materials knowing that these will be used in ways that might not be exactly as the authors of the materials expected.

Third, while some changes are revolutionary in nature, teachers of physics tend to be more evolutionary in their change efforts. Change takes time and professional development designers need to be cognizant of this fact. By their nature, teachers of science are skeptical of change. They have to be shown evidence and allowed to explore the effects of the change for themselves to draw sufficient conclusions necessary to make sustained change efforts.

A fourth recommendation involves the creation of a network of people with similar problems, similar backgrounds, and similar experiences. Hence, the production of professional development and the creation of a network for a subset of unique teachers from the two-year college setting, rather than a generalized ‘one size fits all’ approach must be taken.

The fifth recommendation specifically outlined for professional development practitioners is to view success based on its usefulness in the classroom, not full integration, and implementation of a specific curriculum. Hence, to summarize the researcher’s recommendations:

Recommendations for Professional Developers and Planners at the Two-year College Level

- Recommendation 1: Create a program in which the sharing of knowledge through peer interaction occurs.
- Recommendation 2: Provide modifiable materials to the participants and expect them to make changes, share changes, and report on these changes, based upon their personal situations.
- Recommendation 3: Recognize that teaching change is usually more evolutionary than revolutionary. A professional development designer needs to understand that the process for changing one's teaching takes a great deal of time and effort and should be given adequate amounts of time before casting any final judgment on the effectiveness of the effort.
- Recommendation 4: Create an active network of participants who can share similar success and failure stories, as well as provide mentoring and support.
- Recommendation 5: Define program success based on its usefulness in the teaching classroom. Application of even a small aspect of the process may lead to future change and professional growth.

Additional recommendations from the researcher include ideas that are directed at two-year college administrators, as well as the instructors who teach physics at the community college level. If administration would like to see some revitalization in a physics program which they feel is stagnant or lacking growth, they might consider addressing some of these recommendations for improvement. Additionally, understanding where their physics instructor's philosophical position lies, with respect to change, might also assist beyond these recommendations. An instructor's position, while grounded in strong principles and practice, might be amenable to change, if recommendations similar to the following are instituted within a supportive, collaborative, and trusting environment.

Recommendations for Administrators and Instructors at the Two-year College Level

- Recommendation 1A: Remember that change takes commitment from participating instructors, inner departmental colleagues, administrators, and program developers.
- Recommendation 2A: The professional development of two-year college physics teachers is most effectively done by two-year college peers and possibly at a two-year college setting.
- Recommendation 3A: Partnerships with Universities and Two-year colleges need to be 50-50 partnerships. Gaining a mutual respect and trust for experts is essential for creating an effective collaboration. These collaborations are essential in validating the need for a change.
- Recommendation 4A: Change takes time. Allow for an extended time to reflect, implement, revise, and report on changes. Both administrators and teaching faculty need to recognize this extended time frame if change is ultimately a shared goal.
- Recommendation 5A: One shot workshops provide minimal impetus for change. Sustained interaction is required for movement along a change continuum.

The researcher's recommendations are based upon results from a specific program developed for two-year college physics teachers, some of the recommendations could be generalized to a broader audience. Even though previous research in this context barely exists, its dearth is still a starting point in which this research can make a contribution. Generalization to the audience of the 4 year liberal arts institutions would not be too much of a stretch. Often times these smaller institutes have some parallels to the community college teaching system which would blend nicely with the results of this study. However, the recommendations for creating a more successful transition into the university setting appears to be beyond the scope of this research and any attempt at making recommendations for this level would be futile. This is however, an area other researchers could examine, and is significant with respect to creating improved physics instruction at the university levels.

Comparisons to Others Recommendations

The faculty members interviewed in this study were purposefully sampled to represent participants of the PEPTYC project during its seven cycles, and fifteen years of existence. Although there are individual cases where faculty have completely changed their curriculums to match a research based product, 11 of the 14 instructors interviewed adopted a curriculum piece or teaching methodology where reinvention and invention tracks were the most common. These faculty members tended to work alone on their reinventions and inventions even though they would have liked to work more closely with the collaborations formed in the TYC peer community. They almost all indicated that adoption of curriculum *per se* wouldn't work because of the personal nature of teaching and the unique instructional environments that exist in a two-year college setting.

Dancy and Henderson (2004) suggested that “the educational research community may have a broader impact on actual teaching practices by more fully embracing a mode of interaction with traditional faculty based on cooperation, respect, and support.” Their study is reinforced by this researchers’ conclusion that the use of “peers teaching peers” establishes a trust network where shared ideas and collaboration within a community tends to break down this barrier to successful curriculum dissemination.

Dancy and Henderson (2004) also reported that, “Instructors are not simply “teaching technicians,” they want to, and should be included as active participants in the development process.” They suggested that the research community strive to understand the conditions under which faculty reinvent/invent curriculum so the dissemination process can be done successfully. It appears from the research on the PEPTYC program that a “peer instructional experience” should be an explicit part of the professional development process, an idea that Dancy and Henderson (2004) assert.

As detailed previously in the literature review, Huber (1998) states, “Indeed, at many campuses, a climate of innovation in teaching is already well underway. As one community college professor wrote, ‘This is a very exciting time at my college. Collaborative learning and teaching is the focus, and it is changing my views about the education process" (Huber, 1998, p. 13). Grubb's findings also echoed Huber's, “We were struck by our finding that the most innovative practices seem to emerge from collective efforts, not from individual instructors” (Grubb, 1999, p. 199). Hence, it appears that the peer teaching model described in this dissertation would be an effective practice for professional development (See researchers’ recommendation #1).

The recommendations given for professional development designers, administrative leaders, and two-year college physics faculty, by the researcher, tend to extend upon and modify the five recommendations that Henderson and Dancy (2008) discussed in their additional research work on the topic of barriers to instructional change. Henderson and Dancy offered the following recommendations:

- *Recommendation 1: Provide easily modifiable materials.*
- *Recommendation 2: Disseminate and research ideas in addition to curriculum.*
- *Recommendation 3: Explicitly research the conditions for transfer.*
- *Recommendation 4: View faculty as partners.*
- *Recommendation 5: Acknowledge that change is difficult and support, rather than blame instructors.*

The discussion that parallels these recommendations with the researchers own recommendations follows. Looking specifically at the five recommendations as supplied by Henderson and Dancy (2008), research on the PEPTYC program provides evidence for the substantiation of a number of their conclusions.

Recommendation 1: Provide easily modifiable materials.

The expectation that faculty will engage in local customization was realized by the PEPTYC program directors before their project existed and was carried through in a number of experiences and activities that the two-year college instructors were directed to engage in.

Henderson and Dancy (2008) asserted that, “Faculty should be treated as participants in the development process and should be given the opportunity to adopt materials for their local environment.” PEPTYC provided instructors with easily modifiable materials and communicated to them that they can and should use their own expertise to appropriately integrate the materials into their unique teaching situations. Program Co-director Tom O'kuma not only provided modifiable materials, he encouraged and supported customization through easily edited materials. He also collected these new innovations and curriculum changes and produced copies of such work to each participant via computer disks and project manuals. A number of participants mentioned the fact that Tom O'kuma provided templates of curriculum materials that were easily modifiable, including this comment,

> "I was so happy when I returned from PEPTYC, we were provided this nice CD filled with active learning problems plus we were given copies of each group's projects, all I had to do was choose how and when I was going to use them." (SF51D).

A recommendation that this researcher fully supports and agrees with is that professional development programs need to provide participants with modifiable materials and a venue to share such modifications (See researcher's recommendation #2).

Recommendation 2: Disseminate and research ideas in addition to curriculum.

Henderson and Dancy (2008) asserted that "If faculty is going to modify curriculum effectively, they need to understand both *what* works (details) as well as *why* it works (principles)."

The PEPTYC project leaders attempted to demonstrate both the application of various curricular packages as well as the research basis for the materials. The emphasis was heavy on classroom application; but, the theoretical basis was shared via mini lectures, reading homework related to the research articles, and practical homework exercises. Participants were asked to template materials into a specific curricular style and then class test the materials and provide follow up reports on their effectiveness. As one interviewed participant put it,

> "It was the content piece that it strikes me that we were being taught. Students don't learn through lectures; they learn though experience. The teacher's role is different. But sit somebody down for 2 hours and then we were having some "professional droning" from the "researchers". They were regular graduate lectures. It allowed me to step back and see how this lecture stuff worked for me." (DM31W).

Henderson and Dancy (2008) suggested that,

> "In order to provide faculty with the details and principles knowledge, the educational research community will need to better understand and clearly articulate why a curriculum is successful and not just document its success at one, or a handful, of institutions."

Support to this recommendation came from (TM61M), "Probably the most significant impact the PEPTYC program had for me was that it caused me to "engage in physics education research" by using the pedagogies that have resulted."

A recommendation that this researcher fully supports and agrees with is that professional development programs need to provide participants with a sample of the research ideas that were used to create curriculum packages, assignments, and a follow-up venue to share both success and failure stories in their modifications (See researcher's recommendation #4). Co-Project leader Tom O'kuma also stated,

> "We have always found that sharing the projects that have been created during the workshops have led to both encouragement and effective constructive criticisms, both which are essential for growth and understanding"

Recommendation 3: Explicitly research the conditions for transfer.

According to Henderson and Dancy's (2008) research, "It is not uncommon for curriculum to be produced and disseminated that has not been tested in contexts beyond the environment in which it was developed." They also noted that "Most research-based curricula has been developed at research universities or elite liberal arts colleges. However, both conventional wisdom and available evidence (Sabella, & Bowen, 2003; Sabella, & Cochran, 2004), suggest that these curricula do not always transfer directly to other environments."

As a two-year college teacher himself, the researcher has found virtually no examples, where, within the two-year college environment, curriculum field testing has occurred. Again the research reports on teaching physics at the community college level are extremely rare to find. Rarely do curriculum developers use or report on this "fertile ground" as a testing laboratory for their curriculum innovations. Since Henderson and Dancy (2008) stated that, "In order for dissemination to be successful curriculum development efforts should do the following:

(1) Test and refine curriculum in environments fundamentally different from development site;

(2) Attempt to make explicit what curriculum aspects will transfer and under what conditions the transfer will be successful;

(3) Make recommendations for modifications in different contexts, for example, i.e.

(i) modified for different sized classes,

(ii) modified for schools with less prepared students;

(4) Articulate why some aspects transfer better than others, guiding instructors with their modifications.

The research data from the PEPTYC project shows that dissemination efforts by Physics Education Researchers, at the two-year college level, would be both effective and efficient if the curriculum developers had a better understanding of the environments in which their curriculums were being transferred. As one interviewed participant stated:

> "I really think that the PEPTYC model, the immersive professional development model, persisted. The fact that we had 2 weeks of training, and had follow-up, and follow up … a year commitment, made it much more possible to have an impact. It's necessary to have that immersion but not sufficient. A lot of it depends upon the person, probably their comfort level. Are you satisfied with what you're doing now? And if you are satisfied, you probably are not going to leave an experience like PEPTYC changed that much; cause, its work, you do lots of stuff and it takes work. So if you're kind of satisfied with what you're doing you're not going to change." (DM31W).

Hence, the research data lead the researcher to recommend that further study be done by professional development specialists on the effects of curriculum dissemination for the two-year college audience. This would be very helpful and possibly even essential for building a general model to guide future curriculum development and dissemination projects (See researcher's recommendation # 2A).

Recommendation 4: View faculty as partners.

Henderson and Dancy (2008) expanded on their recommendation by stating,

> "When disseminating educational innovations, the research community should focus on working with faculty as partners, either individually or in small groups to improve instructional practices in individual situations."

Up until the researcher's own work and participation with the people involved with the PEPTYC Institute, he totally felt isolated and unimportant as a part of any curriculum projects. His research agrees with the design of a framework where faculty would be recognized as a valuable part of this process with learning occurring on both sides (See researcher's recommendation # 3A). Support for this is found in one interviewee's statement,

> "I had a wonderful experience. I thought the entire program was extremely well run and executed. I honestly would not change anything. I definitely use many aspects of the program every day. I would also recommend PEPTYC to all physics teachers. If my college were to hire a novice physics teacher, I would insist on them attending this type of program. The leadership teams always made me feel as if I was in control of my learning and they were there to support and help me." (TM61M).

As Robert Beck Clark (2003) noted with the non-sustaining PSSC and Project Physics curriculum reform efforts of the 1960's and Henderson and Dancy (2008) claim,

> "This is in contrast to current dissemination activities describing deficiencies with traditional instructional practices, providing polished ready-to-use curricula, and having change agents promote only the curricula that they developed."

Participants noted in their "negatives about the PEPTYC program that, "sitting down for 2 hours of content lecture wasn't really what the rest of the program was trying to promote" and "if we are going to learn about active learning we should really have it modeled, even when the experts are talking.".

Constructivist principles are well recognized and generally accepted as a good philosophical foundation for students learning physics; however, these ideals are rarely used in professional development and are often replaced by a "teaching by telling" approach to dissemination. As Clark (2003) noted in his interview,

> "Sure he can do it with all this support; but, can I do it at my place and on my terms?" Providing the resources for an instructor to make informed educated choices that are plausible within the given circumstances of their own environment seem to be applicable to a "shared instructional methodology."

Hence, there are a number of models that can produce these results, ranging from one-on-one interaction to more formally organized groups of faculty interested in improving their instruction. Providing the impetus for a two-year college instructor to work with peer groups seemed to provide a positive solution as well.

Recommendation 5: Acknowledge that change is difficult and support, rather than blame instructors.

Henderson and Dancy (2008) suggested, “Too often, an instructor may try an innovation and then blame the method for the poor results. In return, it is common for the research community to blame the instructor for the failure.” From the researcher’s point of view, in the world of teaching it is easy to point fingers at who is to blame. But a philosophy that empowers the physics teacher to make modifications, test their modifications, and share their results with the rest of the teaching and research community is truly what science is founded upon. It appears that the research community needs to be cognizant of the fact that it is difficult to make real and sustained change (See researcher’s recommendation # 3 & #5). According to one interviewed participant,

> “A network of individuals which I can bounce ideas off of would be the greatest benefit I can think of from PEPTYC. Learning about physics education research and continuing to read about the findings from that are a benefit. I have multiple copies of Aaron’s "*Teaching Introductory Physics*" books that I share with new faculty and adjuncts. This single source and the knowledge that I am there to support them in their teaching is what I feel is a key to successful instruction.” (JM61G).

The continuation of research in these areas will assist professional developers in their ability to identify and articulate the factors that make such change difficult. By making instructors aware of these difficult barriers to change, they can become equipped with the tools to achieve effective change. While the Henderson and Dancy (2008) work was done at the four-year college level, the researcher found a number of similar recommendations, which lead to an extra level of validation for his research.

Future Research

While it would be difficult to match this exact research because of its qualitative nature, there are other professional development programs that have been running for a long duration of time. For example the American Association of Physics Teachers Physics Teachers Resource Agents (PTRA) group, just finished a long term cycle of funding this past year, 2007. The PTRA has been a peer teaching peer, professional development group for the past 20 years and is seeking money to continue their efforts in assisting with teaching at the high school level. A long term analysis of its effects would be an excellent follow-up for this research project. Such a project would lead to a greater strength in the conclusion of this research which stated that the peer teaching peer model was successful in its efforts with the two-year college community, especially if success was found in the high school ranks too. Since this long term project was directly connected to the AAPT, it should have resources similar to the project conducted to fulfill the requirements of this dissertation. Hence, doing a similar research project would be an excellent possibility.

Efforts to build a national network of two-year college physics teachers was undertaken in the early 1990's by Mary Beth Monroe, Marvin Nelson and Tom O'kuma, pioneers of the Two Year College in the 21st Century project (Palmer, 2000). While numerous white papers published results and a series of national meetings were developed and took place, the lasting effect of this project on the two-year college teaching community is also an unknown. Recent communications from these pioneers, and the other leaders that they helped with the Two Year College in the 21st Century project training, have brought forward the idea of revisiting the basic premises of their project and creating a new charge for the continuation of some level of scholarly efforts originating at the two year college level. While not a direct link to the PEPTYC project, this would assist in the efforts to disseminate more original research about the two-year college physics teaching community itself.

The two-year college "Physics Workshop Project", directed by Curt Hieggelke and Tom O'kuma, finished their cycle of two-year college professional development activities in 2005, which could be examined for similar characteristics of effective professional development practices. One of the "Workshop Project" leaders, Tom O'kuma, has joined with Dr. Dwain Desbien and has now started a similar program of workshops for the technical education emphasis of the two-year college physics instructional community. This project, which included a new faculty training conference pilot project, was held in March 2008 and has led to future research opportunities for members of the two-year college community and their scholarly efforts. The author of this research was an active participant in the planning, organization, and delivery of this conference experience, which was held at Delta College in Saginaw Bay, Michigan. External evaluation of this pilot project has led the researcher to team up with the project host, Scott Schultz, to attempt to attain funding for a future "New Faculty Training Experience" which will incorporate the findings from this research into the assessment and evaluation program for the grant. The new faculty training conference used a great many of the recommendations from the PEPTYC research project when planning its pilot run, as Scott Schultz was a former PEPTYC participant and many of his philosophical ideas for this project stemmed from conversations with this researcher and his personal PEPTYC experience.

The professional development programs for two-year college physics teaching continue to appear and be funded by the National Science Foundation. It seems that their evaluation process is usually quite surface oriented, and tends to look into the “happiness” coefficient, or the general satisfaction with the effort, rather than take a research based approach to understanding true effectiveness. A deeper evaluation of each of these types of programs quite possibly could lead to a better understanding of how two-year college teachers reach their highest goals in teaching via professional development. Sharing the results of this work with colleagues at two-year college physics teacher meetings, soliciting a new faculty training grant, and securing positions related to the promotion of effective professional development are all possible extensions of this research.

Additional future projects could include forming a consulting company which would allow the researcher to share any on going research results with other two-year college instructors and their college administrations. Currently, a majority of the two-year college physics professional development programs use former AAPT president Karen Johnston and her firm, *The Momentum Group*, to do outside evaluations. Opportunities to learn from and share ideas with Dr. Johnston would be an excellent transition into this process for the researcher. The idea of becoming a University level faculty member whose main function is doing research on teaching, as well as teaching teachers the best and most effective methods for instruction has always been a long term goal for this researcher as well.

Final Thoughts

Professional developers should provide supportive structures to help the faculty they are training cope with the obstacles they are likely to face as they try to make improvements in their instruction. A solid, well thought out set of follow-up activities and mentoring should continue to be part of the professional development process. The PEPTYC program made a sustained effort of including the participants in follow-up activities, even years after their first attendance in the program. This formation of a long-term collaborative support group appeared to the researcher to be one of the special and unique characteristics that would assist a professional development program in providing the needed support for change. While experience doesn't always lead to the process of becoming a "creature of habit"; it appeared that some of the instructors that had taught for a long time (greater that 15 years) were less likely to drastically change their approach to teaching. While faculty readily had the ability to change, or an eagerness, or readiness to change, that appeared much more likely with the participants who had taught fewer years (less than 10 years).

The future viability of a professional development system for teachers of undergraduate college level science requires professional development providers to actively examine the manner in which professional development currently is offered. Professional development providers and curriculum dissemination efforts should attempt to take steps to modify and adapt what is being done at all levels of educational programs. In doing so, the stakeholders from all levels of government, such as the National Science Foundation and other funding agencies, should be involved in planning, implementing, and evaluating these professional development activities. Professional development agencies should be proactive in their efforts to market to and collaborate with other human service delivery areas. Also, professional development activities must be related to a specific set of competencies that instructors should possess—and be based upon a systematically conducted assessment of instructor and program needs. These activities should include a balance between instructor and program-determined priorities.

There is no single "best" approach for professional development. Therefore, multiple approaches should be available to instructors—preferably different approaches that complement one another. Incorporated, as well, within all professional development approaches, must be an evaluation component that provides information both to inform the continuous improvement and to assess the effectiveness of services. Professional development evaluations should document impacts on instructors, programs, and student outcomes. In fact, evaluations should be considered first when planning for professional development, and not simply as an "afterthought." To ensure this occurs, a plan for evaluating professional development evaluations should be developed.

As stated in the beginning of this dissertation,

Deep change differs from incremental change in that it requires new ways of thinking and behaving. It is change that is major in scope, discontinuous with the past and generally irreversible.

---- Robert Quinn (1996)

Robert Quinn's words really do capture the essence of how many science education professionals view the role of change in our ever changing teaching profession. His vision of change in teaching and learning science is philosophically compelling. The task of creating a scientifically literate society places its mark on the lives of everyday citizens across our technologically advancing world and the task of creating such a scientifically literate society is placed upon the teachers who use professional development as a means to assist in this effort, an ever more difficult challenge. As a researcher, one could only hope that this scholarly work assists future professional development programs as they provide opportunities to change the teaching profession in the two-year college.

BIBLIOGRAPHY

American Institute of Physics. (2000). *National Research Council Report Addresses Education of Science and Math Teachers:*

Bulletin of Science Policy News (No. 107). College Park, MD: American Institute of Physics.

Alliger, G. M., & Janak, E. A. (1989). Kirkpatrick's levels of training criteria: Thirty years later. *Personnel Psychology, 42*(2), 331-342.

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

Arons, A. B. (1997). *Teaching Introductory Physics*. New York: Wiley.

Banachowski, G. (1996). Perspectives and Perceptions: The use of part-time faculty in community colleges. *Community College Review, 24*(2), 49-62.

Barnsley, J. R. (1992). *An historical review of efforts to define the effective community college teacher: A chronological analysis of the literature from 1920 to 1989 (Effective teaching literature).* Unpublished doctoral dissertation, University of Arkansas., Fayetteville, AR.

Barth, R. (1990). *Improving schools from within: Teachers, parents, and principals can make the difference*. San Francisco, CA: Jossey-Bass.

Becker, H. S., & Geer, B. (1970). Participant observation and interviewing: A comparison. In W. J. Filstead (Ed.), *Qualitative methodology: Firsthand involvement with the social world* (pp. 133-142). Chicago, Il: Markham Publishing Company.

Beckhard, R. (Ed.). (1969). *Organization Development: Strategies and Models*. Reading, MA: Addison-Wesley.

Berman, P., & McLaughlin, M. W. (1978). *Federal Programs supporting Educational Change. Volume VIII: Implementing and Sustaining Innovations.* Santa Monica, CA: Rand Corporation, 1978.

Berman, P., & Weiler, D. (1987). *Exploring faculty development in California higher education. Volume I, executive summary and conclusions* (No. 8818). Berkeley, CA.

Bernthal, R. R. (1995). Evaluation that goes the distance. *Training and Development Journal, 49*(9), 41-45.

Blackburn, R. T., & Lawrence, J. H. (1995). *Faculty at Work, Motivation, Expectation, Satisfaction*. Baltimore, MD: Johns Hopkins University Press.

Bogdan, R. C., & Bilken, S. K. (1982). *Qualitative Research for Education An Introduction to Theory and Methods*. Boston, MA: Allyn and Bacon.

Bogdan, R. C., & Bilken, S. K. (1998). *Qualitative Research in Education: An Introduction to Theory & Methods*. Boston, MA: Allyn and Bacon.

Boice, R. (1990). *The new faculty member: Supporting and fostering professional development*. San Francisco, CA: Jossey-Bass.

Boice, R. (1991). New faculty as teachers. *Journal of Higher Education, 62*, 150-173.

Bransford, J. D., & Schwartz, D. (1999). Rethinking transfer: A simple proposal with multiple implications. *Review of Research in Education, 24*, 61-100.

Brinkley, D. (1994, April 3,). Educating the Generation Called 'X. *Washington Post Education Review*.

Brown, B. L. (2000) New Learning Strategies for Generation X: ERIC Clearinghouse on Adult Career and Vocational Education.

Burgess, R. (1984). *The research process in educational settings: Ten case studies*. London, UK: Falmer Press.

Caine, R. N., & Caine, G. (1997). *Education on the edge of possibility*. Alexandria, VA: Association for Supervision and Curriculum Development.

Cannon, J. R., & Crowther, D. T. (March 1997). *An autopsy of an elementary science program implementation.* Paper presented at the National Association for Research in Science Teaching Annual Meeting, Oak Brook, IL.

Carter, D. J., & Ottinger, C. A. (1992). Community college faculty: A profile. *Research Briefs, 3*(7). Washington, D.C.: American Council on Education

Caudron, S. (1997). Can Generation Xers be trained? *Training and Development Journal, 51*(3), 20-24.

Clark, R. B. (2003). Pre-Thesis Interview. In Leif, T. R. (Ed.). College Station, TX.

Clark, R. B., & O'kuma, T. L. (1990). *Texas Two Year College Physics Enhancement Program* (NSF Grant Proposal). College Station, TX: Texas A&M University

Cohen, A. M., & Brawer, F. B. (1972). *Confronting identity: The community college instructor*. Englewood Cliffs, NJ: Prentice-Hall.

Cohen, A. M., & Brawer, F. B. (1984). *The collegiate function of community colleges: Fostering higher learning through curriculum and student transfer*. San Francisco, CA: Jossey-Bass.

Cohen, A. M., & Brawer, F. B. (1996). *The American Community College* (3rd Edition ed.). San Francisco, CA: Jossey-Bass.

Cresswell, J. W. (1998). *Qualitative inquiry and research design: choosing among five traditions*. Thousand Oaks, CA: Sage Publications.

Dancy, M. H., & Henderson, C. (2004). *Beyond the Individual Instructor: Systemic Constraints in the Implementation of Research-Informed Practices.* Paper presented at the 2004 Physics Education Research Conference, Sacramento, CA.

Dancy, M. &. Henderson., C. (2007). Framework for articulating instructional practices and conceptions. *Physical Review Special Topics Physics Education Research, 3*(1), 010103.

Denzin, N. K., & Lincoln, Y. S. (2000). *Handbook of Qualitative Research.* Thousand Oaks, CA: Sage Publications.

Desbien, D. M. (2002). *Modeling Discourse Management Compared to other Classroom Management Styles in University Physics.* Arizona State University, Tempe.

De Souza Barros, S., & Elia, M. F. (1998). "Physics Teachers" Attitudes: How do they affect the reality of the classroom and models for change?" In A. Tiberghien, et al (Ed.), *Connecting Research in Physics Education with Teacher Education*: ICPE.

DeBard, R. (1995). Preferred education and experience of community college English faculty: Twenty years later. *Community College Review, 23*(1), 3350, p. 34.

Digranes, J. L. A., & Digranes, S. H. (1995). Current and Proposed Uses of Technology for Training Part-Time Faculty. *Community College Journal of Research and Practice, 19*(2), 161-169.

Eisenhower Clearinghouse, (1998). Ideas that Work: Science Professional Development. In S. Loucks-Horsley & e. al. (Eds.), *Designing Professional Development for*

Teachers of Science and Mathematics, Ch 4 (pp. 70). Columbus, OH: Ohio State University.

Ellis, S. S. (1982). Matching Evaluations to the type of Staff Development Activity at the Building Level. *Journal of Staff Development, 3*(1), 48-55.

Ellsworth, J. B. (Ed.). (2000). *Surviving Change: A Survey of Educational Change Models*. Washington, DC: Office of Educational Research and Improvement.

Emerson, J. D., & Mosteller, F. (2000). Development Programs for College Faculty: Preparing for the Twenty-first Century in Educational Media and Technology yearbook 2000 In Branch, R. M. & Fitzgerald, M. A. (Eds.), (Vol. 25, pp. 26-42).

Erlandson, D. A., Harris, E. L., Skipper, B. L., & Allen, S. D. (1993). *Doing Naturalistic Inquiry*. Newbury Park, CA: SAGE Publications.

Festinger, L. (1957). *A Theory of Cognitive Dissonance*. Stanford, CA: Stanford University Press.

Finch, J., & Mason, J. (1990). *Studies in Qualitative Methodology*. London, England: JAI Press.

Finkelstein, N. D., & Price, E. (2004). *Seeding Change: the Challenges of Transfer and Transformation of Educational Practice and Research in Physics (Part 1).* Paper presented at the 2004 Physics Education Research Conference, Sacramento, CA.

Foertsch, J., Millar, S. B., Squire L., & Gunter, R. (1997). 'Persuading Professors: A study of the Dissemination of Educational Reform in Research Institutions' University of Wisconsin–Madison, LEAD Center, Madison.

Frankel, J. (1973). *Junior College Faculty Job Satisfaction*. Los Angeles, CA: ERIC Clearinghouse for Junior Colleges.

Fullan, M. (1991). *The New Meaning of Educational Change*. New York, NY: Teachers College Press.

Fullan, M. (2001). *The New Meaning of Educational Change* (2nd ed.). New York, NY: Teachers College Press.

Fullan, M. (Ed.). (2007). *The New Meaning of Educational Change* (3rd ed.) New York, NY: Teachers College Press.

Furniss, W. T. (1981). *Reshaping Faculty Careers.* Washington, DC: American Council on Education.

Gappa, J. M., & Leslie, D. W. (1993). *The Invisible Faculty: Improving the Status of Part-timers in Higher Education*. San Francisco, CA: Jossey-Bass.

Gick, M. L., and Holyoak, K. J. (1980). Analogical Problem Solving. *Cognitive Psychology, 12*, 306-355.

Glasser, B. G. (1978). *Theoretical Sensitivity: Advances in the Methodology of Grounded Theory*. Mill Valley, CA: Sociology Press.

Glasser, B. G., & Strauss, A. L. (1967). *The Discovery of Grounded Theory: Strategies for Qualitative Research*. Chicago, IL: Aldine Publishing Co.

Grubb, N. W. (1999). *Honored but Invisible: An Inside look at Teaching in Community Colleges*. New York, NY: Routledge.

Gunstone, R. F., & White, R. T. (1998). "Teachers' Attitudes About Physics Classroom Practice". In A. Tiberghien (Ed.), *Connecting Research in Physics Education with Teacher Education*: ICPE.

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

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics, 66*(1), 64-74.

Hall, G. E., & M., H. S. (1987). *Change in Schools: Facilitating the Process*. New York, NY: University of New York Press.

Hamblin, A. C. (1974). *Evaluation and Control of Training*. New York, NY: McGraw-Hill.

Hammond, R. L. (1973). Evaluation at the local level. In B. R. Worthen & J. R. Sanders (Eds.), *Educational Evaluation: Theory and Practice* (pp. 157-169). Belmont, CA: Wadsworth.

Hammons, J., Wallace, T. H. S., & Watts, G. (1978). *Staff Development in the Community College: A Handbook.* (Topical Paper No. 66). Los Angeles, CA: ERIC Clearinghouse for Junior Colleges,.

Henderson, C. (2005). The challenges of instructional change under the best of circumstances: A case study of one college physics instructor. *American Journal of Physics, 73*(8), 778–786.

Henderson, C. (2008). Promoting Instructional Change in New Faculty: An Evaluation of the Physics and Astronomy New Faculty Workshop. *American Journal of Physics, 76*(2), 179-187.

Henderson, C. & Dancy, M. H. (2008). Physics Faculty and Educational Researchers: Divergent Expectations as Barriers to the Diffusion of Innovations. *American Journal of Physics (Physics Education Research Section) 76*(1) 79-91.

Hestenes, D. (1987). Toward a Modeling Theory of Physics Instruction. *American Journal of Physics, 55*, 440–454.

Holton, E. F. (1996). The Flawed Four-level Evaluation Model. *Human Resource Development Quarterly, 7*(1), 5-21.

Hord, S. M., Rutherford, W. L., Huling-Austin, L., & Hall, G. E. (1987). *Taking charge of change*. Alexandria, VA: ASCD.

Hornblower, M. (June 9, 1997). Great Xpectations, *Time Magazine 129,* 58-68.

Huber, M. T. (1998). *Community College Faculty Attitudes and Trends, 1997* (No. R309A60001; NCPI-4-03). Stanford, CA: National Center for Postsecondary Improvement.

Illinois CC Board. (1988). *Illinois Community College Board Twelfth Biennial Report, 1987-1988.* Springfield: Illinois Community Coll. Board,.

Joyce, B., & Showers, B. (1988). *Student Achievement through Staff Development.* White Plains, New York: Longman.

Kanter, R.M.(1999) *The Enduring Skills of Change Leaders*. Leader to Leader; Nr. 13 http://www.pfdf.org/leaderbooks/l2l/summer99/kanter.html)

Kaufman, R., & Keller, J. M. (1994). Levels of evaluation : Beyond Kirkpatrick. *Human Resource Development Quarterly, 5*(4), 371-380.

Keim, M. C. (1989). Two-year college faculty: A research update. *Community College Review,, 17*(3), 34-43.

Kelly, W. (2003). Former AAPT President, Pre-Thesis Interview. In Leif, T. R. (Ed.) Gainesville, GA.

Kirkpatrick, D. L. (1959). Techniques for Evaluating Training Programs. (Beginning A four-part series). *Journal for the American Society of Training Directors, 13*(11).

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

Kirkpatrick, D. L. (1978). Evaluating In-house Training Programs. *Training and Development Journal, 32*(9), 6-9.

Kirkpatrick, D. L. (1996). Great ideas revisited. Techniques for Evaluating Training Programs. Revisiting Kirkpatrick's four-level model. *Training and Development Journal, 50*(1), 54-59.

Knowles, M. S. (1986). *Using Learning Contracts*. San Francisco, CA: Jossey-Bass.

Kraft, N. (1998). Components for Effective Professional Development. *Texas Elementary Principals and Supervisors Association Journal*, 31-32.

Kyle, W. C., Jr., Bonnstetter, R. J., Sedotti, M. A., & Dvarskas, D. (1989). *Implementing an effective elementary program: The process of initiating change and its effect on students' attitudes.* Paper presented at the 62 Annual Meeting of the National Association for Research in Science Teaching, San Francisco, CA.

Kuhn, T., (Ed.) (1962, 1970). *The structure of scientific revolutions* (2nd ed.): University of Chicago Press.

Kutner, M. T. P., J. (Ed.). (1997). *Looking to the Future: Components of a Comprehensive Professional Development System for Adult Educators* PRO-NET Research Institute, American Research Institute, Washington D.C.

Laboratories, R. E. (1995). *Facilitating systemic change in science and mathematics education: A toolkit for professional developers.* Andover, MA: The Regional Laboratory for Educational Improvement of the Northeast and Islands.

Lawrence, J. H. (November, 1989). *Faculty in community colleges: Differences between the doctorally and non-doctorally prepared.* Paper presented at the Annual Meeting of the Association for the Study of Higher Education, Atlanta, GA.

Laws, P. (1991). Workshop Physics: Learning introductory physics by doing it. *Change Magazine*, 20-27.

Levinson-Rose, J., & Menges, R. J. (1981). Improving college teaching: A critical review of research. *Review of Educational Research, 51*, 403-434.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Beverly Hills, CA: Sage Publications.

Little, J. W. (1981). *School success and staff development in urban desegregated schools: A summary of recently completed research*. Boulder, CO: Center for Action Research.

Little, J. W. (1982). Making sure: Contributions and Requirements of Good Evaluation. *Journal of Staff Development, 3*(1), 25-47.

Little, J. W. (1993). Teachers' professional development in a climate of educational reform. *Educational Evaluation and Policy Analysis, 15*(2), 129-151.

Lopez, R. E., & Schultz, T. (2001). Two Revolutions in K-8 Science Education. *Physics Today*.

Losyk, B. (May, 1997). How to Manage an Xer. *Current, 392*.

Louck-Horsley, S., & Stiegelbauer, S. (1991). Using knowledge of change to guide staff development. In A. Lieberman & L. Miller (Eds.), *Staff development for education in the 90's: New demands, new realities, new Perspectives.* New York, NY: Teachers College Press.

Loucks, S., & Melle, M. (1982). Evaluation of Staff Development: How do you Know it Took? *Journal of Staff Development, 3*(1), 102-117.

Loucks-Horsley, S., Harding, C. K., Arbuckle, M. A., Murray, L. B., Dubea, C., & Williams, M. K. (1987). *Continuing to learn: A guidebook for teacher development*. Andover, MA: Regional Laboratory for Educational Improvement of the Northeast & Islands.

Loucks-Horsley, S., Hewson, P. W., Love, N., & Stiles, K. E. (1998). *Designing professional development for teachers of science and mathematics*. Thousand Oaks, CA: Corwin Press.

Loucks-Horsley, S., Love, N., Mundry, S., Hewson, M. S., W., P., & Stiles, K. E. (2003). *Designing Professional Development for Teachers of Science and Mathematics*. Thousand Oaks, CA: Corwin Press.

Mariampolski, H. (2001). *Qualitative market research: a comprehensive guide*. Thousand Oaks, CA: Sage Publications.

Marshood, N. (1995). Community college administrators and faculty scholarship: A pilot study. *Community College Review, 23*(1), 51-62.

Mazur, E. (1997). *Peer Instruction: A User's Manual*. Upper Saddle River, NJ: Prentice-Hall.

McBeath, C. (1991). Research into curriculum dissemination in TAFE. *Issues In Educational Research, 1(1), 1991, 23-30., 1*(1), 23-30.

McDermott, L. C. (1990). Millikan Lecture 1990: What we teach and what it learned - Closing the gap,. *American Journal of Physics, 59*, 301.

McDermott, L. C. (1997). *Bridging the gap between teaching and learning: The role of research.* Paper presented at the International Conference on Undergraduate Physics Education.

McDermott, L. C., & Redish, E. F. (1999). Resource Letter: PER -1: Physics Education Research. *American Journal of Physics, 67*(9), 755-767.

McKelevey-Cahper, G. (Ed.). (1984). *"Generation X: reactions to working conditions"*. Vanier, Ontario.

McMahon, E. J. (1990). *Implementing an elementary science program through community resources* (No. (ERIC Document Reproduction Service No. ED 325 358)): Nova University.

Merriam, S. B. (1988). *Qualitative Research and Case Study Applications in Education*. San Francisco: Jossey Bass.

Minichiello, V., Aroni, R., Timewell, E., & Alexander, L. (1995). *In-Depth Interviewing* (2nd Edition ed.). Sydney, Australia.: Longman.

Monroe, M. B., O'kuma, T. L., & Hein, W. (2005). Strategic Programs for Innovations in Undergraduate Physics at Tow-Year colleges: Best Practices of Physics Programs. In M. J. Norton (Ed.). College Park, MD: AAPT.

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

National Resource Council. (1996). *National Science Education Standards*. Washington, DC: NAP.

National Resource Council. (2000). *Educating Teachers of science, Mathematics, and Technology: New Practices for the New Millennium*. National Academy Press, Washington DC: Center for Education National Research Council.

Neuschatz, M., Blake, G., Friesner, F., & McFarling, M. (1998). *Physics in the Two-Year Colleges*. College Park, MD: American Institute of Physics.

Newmann, F. M., Marks, H.M., & Gamorman, A. (1995). *Authentic Pedagogy: Standards that Boost Student Performance*. Madison, WI.

Newstrom, J. W. (1978). Catch-22: The problems of incomplete evaluation of training. *Training and Development Journal, 32*(11), 22-24.

O'Banion, T. (1972). *Teachers for tomorrow: Staff development in the community junior college.* Tucson, AZ: University of Arizona Press.

Outcalt, C. L. (2000). Community college teaching: Toward collegiality and community. *Community College Review, 28*(2), 57-71.

Pajares, M. F. (1992). *Review of Educational Research, 62*, p. 307.

Palmer, J. C. (Ed.). (2000). *A Model for Reform, Two-Year Colleges in the Twenty-First Century: Breaking Down Barriers*. College Park, MD: American Association of Physics Teachers.

Patton, M. Q. (1990). *Qualitative evaluation and research methods* (2nd Edition ed.). London: Sage.

Patton, M. Q. (1978). *Utilization-Focused Evaluation*. Beverly Hills, CA: Sage.

Patton, M. Q. (1990). *Qualitative Evaluation Methods*. Thousand Oaks, CA: Sage.

Peterson, P. L., Fennema, E., Carpenter, T.P., & Loef, M. (1989). *Cognition and Instruction, 6*, 1-40.

Piaget, J. (1995). *The equilibration of cognitive structures*. Chicago, IL: University of Chicago Press.

Quinn, R. E. (1996). *Deep Change: Discovering the Leader Within*. San Francisco, CA: Jossey-Bass.

Rebello, N. S., Zollman, D. A., Allbaugh, A. R., Engelhardt, P. V., Gray, K. E., Hrepic, Z., et al. (2005). Dynamic Transfer: A Perspective from Physics Education Research. In J. P. Mestre (Ed.), *Transfer of Learning from a Modern Multidisciplinary Perspective*. Greenwich, CT: Information Age Publishing Inc.

Reed, S. K., Ernst, G. W., & Banerji, R. (1974). The role of analogy in transfer between similar problem states. *Cognitive Psychology, 6*, 436-450.

Reif, F. (1995). Millikan Lecture 1994: Understanding and teaching important scientific thought processes. *American Journal of Physics, 63*, 17.

Richardson, V. (1996). "The role of attitudes and beliefs in learning to teach,". In J. Sikula (Ed.), *Handbook of research on teacher education,* (2nd ed. ed., pp. 102-119). New York: Macmillan.

Rifkin, T. (1998). Differences between the professional attitudes of full- and part-time faculty. *ERIC Document Reproduction No. ED 417 783*.

Riley, R. W. (1993). The Emerging Role of Professional Development in Education Reform, Secretary of Education, *On Common Ground, 1*.Washington D.C.

Rogers, A. (1996). *Teaching Adults* (2nd ed.). Buckingham, UK: Open University Press.

Rogers, E. M. (Ed.). (1995). *Diffusion of Innovations*. New York: Simon & Schuster.

Sabella, M. & Cochran, G. (2004). *Evidence of intuitive and formal schemas in student responses: Examples from the context of dynamics.* Paper presented at the 2003 Physics Education Research Conference

Sabella, M.& Bowen, S. (2003). Physics Education Research with special populations: How do we characterize and evaluate the special needs and resources of students who are underrepresented in stem education, *AAPT Physics Education Research Conference*. Madison, WI.

Sachs, P. (Ed.). (1996). *Generation X goes to College. An Eye-opening Account of Teaching in Post-Modern America*. Chicago, IL: Open Court Publishing Company.

Saroyan, A., & Amundsen, C. (Eds.). (2004). *Rethinking teaching in higher education: from a course design workshop to a faculty development framework*. Sterling, VA: Stylus Publishing.

Schatzman, L., & Strauss., A. L. (1973). *Field research: Strategies for a natural sociology.* Englewood Cliffs, NJ: Prentice-Hall.

Scriven, M. S. (1972). Pros and cons about goal-free evaluation. *Evaluation Comment, 3*(4), 1-7.

Seppanen, L. (1990). *Washington Community College faculty development survey results: A summary of the results of survey of all full-time faculty* (No. Operations Report No.90-3). Olympia, WA: Washington State Board for Community College Education.

Seymour, E. (2001). Tracking the process of change in U.S. undergraduate education in science, mathematics, engineering, and technology. *Science Education 86*, 79-105.

Showers, B. T., & Joyce, B. (1982). *Transfer of Training: the Contribution of Coaching*. Eugene, OR: Centre for Educational Policy and Management.

Shulman, L. S. (1997). Professing the Liberal Arts. In R. Orrill (Ed.), *Education and Democracy: Re-imagining Liberal Learning in America*. New York: College Board Publications.

Sokoloff, D. R. (2001). *Interactive Lecture Demonstrations*: New York, NY: John Wiley & Sons.

Smith, A. (Ed.). (1998). *Training and Development in Australia*. Sydney, Australia: Butterworths.

Sorcinelli, M. D. A., A. E. . (1992). *Developing new and junior faculty* San Francisco, CA: Jossey-Bass.

Spradley, J. (1979). *The ethnographic interview*. New York: Holt, Rinehard and Winston.

Stainback, S. B., & Stainback, W. (1988). *Understanding and conduction qualitative research*. Dubuque, IA: Kendall/Hunt.

Stake, R. E. (1995). *The Art of Case Study Research*. Thousand Oaks, CA: Sage Publications.

Stewart, C. J., & Cash, W. B. (1988). *Interviewing: Principles and Practices*. Dubuque, Iowa.: William C. Brown Publishers.

Stufflebeam, D. L. (1969). Evaluation as enlightenment for decision making. In B. H. & W. A.B. (Eds.), *Improving educational assessment and an inventory of measures* *of affective behavior.* Washington, DC: Association for Supervision and Curriculum Development.

Stufflebeam, D. L. (1971). The relevance of the CIPP evaluation model for educational accountability. *Journal of Research and Development in Education, 5*(1), 19-25.

Taylor, S. J., & Bogdan, R. (1984). *Introduction to Qualitative Research Methods: The Search for Meanings*. New York, NY: John Wiley and Sons.

Taylor, S. J., & Bogdan, R. C. (1984). *Introduction to qualitative research methods: The search for meanings* (2nd edition ed.). New York, NY: John Wiley and Sons.

Tyler, R. W. (1942). General statement on evaluation. *Journal of Educational Research, 35*(4), 492-501.

Van Heuvelen, A. (1991). Overview, Case Study Physics. *American Journal of Physics, 59*, 898.

Wagschal, K. (1997). I Became Clueless Teaching the GenXers. *Adult Learning, 8*(4), 21-25.

Watts, G. E. H., J.O. (Ed.). (2002). *Professional development: Setting the context* Vol. 2002: Wiley Periodicals, Inc., .

Weimer, M. L., L. F. (Ed.). (1991). *Instructional interventions: A review of the literature on efforts to improve instruction in Higher education: Handbook of theory and research* (Vol. VII). New York: Agathon Press.

Whitaker, T. R. (1993). On Common Ground: Who We Are, Where We're Going. *On Common Ground, 1*.

Wilson, J. M. (1994). The CUPLE Physics Studio. *The Physics Teacher, 32*, 518-523.

Yin, R. K. (1994). *Case study research: Design and methods* (2nd Edition ed.). Thousand Oaks, CA: Sage Publications.

Zappia, C. A. (1995). *History in the 1990s: The status of the profession in the community colleges.* Paper presented at the National Conference of the Community College Humanities Association, Washington, DC.

Zollman, D. A. (1995-2000). *Visual Quantum Mechanics: A Qualitative, Computer-based Introduction to Principles of Modern Physics*: NSF Grant #9452782.

APPENDIX A: Interview Questions for the Workshop Presenters

This set of questions will be posed to the faculty member who designed and presented the workshop experiences for the participants. The goal is to seek their perspective in each of the first three levels of evaluation of the professional development experiences as per the framework, as seen via an education based lens.

Level 1: Attitudes	What were participants' attitudes about the workshop before they began? Were the participants willing to participate? Did the participants feel that their time was well spent? Did the participants appear to be satisfied with their learning experiences in their workshop? What were the main positive points cited by the participants about the workshop? What were the main negative points or complaints cited by the participants ? What suggestions, in any did the participants provide about future workshop? How would you rate the participants' level of enthusiasm regarding teaching and learning in general? Were the participants enthusiastic about implementing what they had learned the workshop to their own classrooms? How did (or did) participants attitudes about teaching and learning appear to change after completing the workshop?
Level 2: Learning	What do you think the participants learned at the workshop? Did what they learn match what you had intended for them to learn? In what way, in any do you think participants views about teaching and learning change in any way as a result of the workshop?

Level 3: Transfer	*During the workshop:* Did the participants seem to support implementation of this type of instruction? Did the participants plant to implement what they had learned at the workshop at their home institutions? In what ways did the participants plan to adapt the materials learned at the workshop to be used at their home institutions? What was the anticipated impact on student learning by the participants? *After the workshop:* To what extent did the participants implement what they had planned when they returned to their home institution? What adaptations, if any were made by the participants to the curriculum and instructional strategies as they adapted these to their home institutions? In what ways, was the information learned at the professional development experience being implemented? How frequently were the strategies learned at the workshop being implemented in their home institutions Was implementation advocated, facilitated, and supported at the home institution? What problems, if any were encountered by the participants as they attempted to implement what they had learned at their home institution? Were problems, if any addressed quickly and efficiently? Were resources available to support implementation at the home institution? What reward structure existed at the home institution to promote improvements to teaching and learning?
Level 4: Results	What is the impact of the implementation on student learning? Did participants' learning improve student performance or achievement? Are students more active and responsible as learners? Are students more confident learners? Are students more engaged in learning? Is student behavior improving? Is student attendance improving?

APPENDIX B: Survey Questions for Workshop Participants

The following e-mail correspondence will provide the researcher with the participants' perspective on the mission, quality and efficiency of the PEPTYC Professional Development Program of which you were a part of during some phase, over the past 2 decades.

Text of E-mail

Dear former PEPTYC Participant,

Hello, my name is Todd Leif and I am a two year college physics teacher from Cloud County Community College in Concordia, KS. I, like you , attended Robert Beck Clark and Tom Okuma's Texas A&M PEPTYC Institutes a few years ago. Some of you might know me because I attended PEPTYC IV and shared 2 years of time with you. Others might remember me in an instructional roll during PEPTYC VI, and PEPTYC VII. Many of you met me during one of the 10 different Texas Sections –AAPT meetings that I attended and were held across the vast miles of Texas. I am still a full time instructor at Cloud County Community College and I am currently trying to finish a PhD at Kansas State University that I started a few years ago.

I am e-mailing you to ask if you would be willing to help me on my dissertation project. I am conducting an e-mail survey of all former project participants and plan on completing a small set of phone interviews from this response group in an effort to determine what was the lasting effect of the PEPTYC project on Two-Year College Physics Instruction. I realize that many of you have adjusted, altered, and even changed the roads that you were traveling while attending the PEPTYC Institutes, however I could really use your help.

If you are willing to be interviewed; I would like you to fill out the following questionnaire and I will get back to you with additional correspondence regarding when I would like to ask you some more direct questions.

If you are unwilling to be interviewed but would like to help me get a broad idea of what you might be doing since you last attended PEPTYC, I would love to have you fill out this questionnaire as well.

You will be under no obligation to participate in the interviews and your responses will not be traced back to you in any way. I really just need some information about who you are and what your teaching style is like today.

Either way, please at least respond and tell me you got this e-mail to assist me in my analysis. I will send out up to three attempts to get some form of response from each of you.

Will you be willing to be interviewed by me over the phone to (please check one)

- Yes I am willing to do a phone interview with you.
- No I am not willing to be called but I will fill out your survey.
- No I am not willing to be called or fill out your survey but I did get your message.

Thank you for helping me with my graduate dissertation. Thank you for assisting one of your two year colleges teaching colleagues in their scholarly efforts.

Todd R. Leif

Physics Professor Cloud County Community College

Instructions

Please read the following 10 questions and reply based upon your experiences in the PEPTYC (Physics Enhancement Project for Two Year College Physics Instructors) Program and your knowledge after participation in the program itself. It would be fine if you would place your answers into this e-mail form and send back the answers embedded with the response. You will also be asked a couple of additional questions that will assist me in the coding of answers and the selection of a sample that is stratified across the various cycles of the PEPTYC project.

Thank you for your assistance. I will contact you by phone after comparison of the various replies and will expand our interview if you are willing and selected for additional study after this initial analysis.

Questions

1. In your opinion what was the PEPTYC project trying to accomplish (goals), locally, regionally, and nationally?
2. Now that the project is totally completed, how well are these current intentions being realized, i.e. in what ways is the training you received still being implemented by you in your current classroom, program, and professional activity?
3. Based upon the costs of these benefits, how well did you feel the project was run and where could changes have been made?
4. What are some of the specific benefits you gained from the PEPTYC program?
5. What are some of the specific barriers that the PEPTYC program needed to address, but weren't accomplished for you?

6. What were the most positive parts of the PEPTYC program for you?
7. What were the most negative parts of the PEPTYC program for you?
8. How did the PEPTYC program influence or change your teaching style. i.e. describe your teaching style before the program, after the program, and what it is like today?
9. If given the opportunity to attend the same or a similarly focused professional development program today, would you attend the program? Why or why not.
10. Summarize your feelings about the PEPTYC program in a brief narrative. Include any ideas or thoughts that you think future program initiatives might need to address or want to focus on to make this type of experience a meaningful one.

Demographics

Information will be classified and coded and will not be reflected/identified in the research report. We are currently interviewing 14 people who are a broad spectrum across all 7 cycles and all genders.

Name:

Gender:

College where you are employed:

Main Area of Teaching Emphasis:

Degree Level and Subject Area:

Number of years teaching physics:

PEPTYC Cycle you attended (years):

Preferred E-mail Address

Preferred Phone Number

APPENDIX C: Interview Questions for Workshop Participants

The participants who respond to the E-mail survey (Appendix B) and agreed to be interviewed will be interviewed using a semi-structured format. The researcher will start with the interview protocol questions.

The interview protocol is designed to address all four levels of the ALTER framework.

Semi-Structured Interview Protocol

- What was your purpose in attending the PEPTYC Professional Development Institute?
- On a scale from 1 to 4 how committed to this purpose were you?

  1 strongly committed- 2 somewhat committed 3-loosely committed 4-not committed
- Recalling the PEPTYC Professional Development Institute, can you recall your attitudes toward teaching and learning right after the Institute was completed?
- How were these views different from those you had before you attended the PEPTYC Program?
- How would you describe your current personal vision about teaching and learning and your philosophy of instruction?
- What would you describe as your vision of teaching and learning after and before attending the PEPTYC Institute?
- A number of specific experiences were created for you at the PEPTYC institute. Rate these specific methods on their effectiveness in shaping your current vision of teaching and learning.

- MBL Activities
- Lecture Presentations from Research Physicists
- Curriculum and Pedagogical Presentations/Workshops
- Critical Issue Cracker-Barrel Discussion Groups

➢ You might recall that each of the leaders of the PEPTYC Project had an area of emphasis. Please respond by rating the following areas based upon their effectiveness in assisting you to change the way you think about teaching and learning.

- These areas included

➢ Lab activities,

- MBL
- Traditional
- Open ended

➢ Active learning techniques for lectures,

- Peer Instruction
- Ranking Tasks and Overview Case Studies
- Large and Small Contextual Problem
- Promoting Conceptual Understanding

➢ Classroom management techniques,

- Contextual Questions
- Just in Time Teaching
- Classroom Discourse Management

➢ Physics Education Research,

- Modern Physics Applications
- Quantum Optics Applications
- To what extent do you feel that these activities have lead you to these points of view about learning and teaching?
- What did you hope to gain from attending the PEPTYC Professional Development Institutes?
- Describe your classroom management style and teaching techniques after your participation at PEPTYC.
- Describe your classroom management style and teaching techniques as they were before you went to PEPTYC.
- Since going to PEPTYC, have you changed your teaching activity? If so, how have it changed? If not what are the reasons that inhibited change
- Since going to PEPTYC, have you changed your professional activity? If so, how have they changed? If not, what are the reasons that inhibited change
- Do you use any specific techniques or strategies of teaching today that you learned at PEPTYC? If so, what strategies do you use?
- In what ways have you adapted instructional strategies or curricula that you learned at PEPTYC to suit your own teaching setting immediately following the institute?
- In what ways have you adapted instructional strategies or curricula that you learned at PEPTYC to suit your own teaching setting now several years later?
- How have these changes been received by your students?

- What impact have these changes had on your student learning and attitudes toward learning? Do you have more than anecdotal evidence for this?
- How have these changes been received by your faculty colleagues?
- Have any of your faculty colleagues adapted or adopted any of these strategies or techniques to their teaching?
- How has the response been of your administration to implementing the strategies and changes that you suggested based on your activities at the PEPTYC Institute?
- What is the institutional climate you find at your institution to support your efforts at implementing the strategies and techniques in your classroom?

Each of the leaders of the PEPTYC Project had an area of emphasis. Please respond to the following area's based upon their effectiveness in assisting you to change the way you think about teaching and learning. These included areas such as

  - Lab activities,
  - Active learning techniques for lectures,
  - Classroom management techniques,
  - Physics Education Research,
  - Modern physics applications or Quantum Optics Applications

Additionally, specific pedagogical topics included workshops from:

  - Tom O'kuma who talked about MBL activities,
  - Marybeth Monroe highlighted issues and concerns in the Two Year College setting using cracker barrels.
  - Robert Tyndall modeled Workshop Physics, and
  - Robert Beck Clark gave traditional lectures with innovative twists.

There were many others who also demonstrated, modeled, and lead discussions and activities during the PEPTYC institutes.

- Recalling all of these phases of the project, which of these activities do you think changed the way you think about teaching and learning?
- Why do you think that this affected you the way it did?
- In what ways did you change your teaching for students?
- In what direction did your focus go after you attended these workshops?

The PEPTYC Professional Development program was designed to encourage exploration into current trends and models of physics instruction. It also provided an opportunity to examine some cutting edge physics research at a major research institution.

Before you attended the PEPTYC Program how would you rate what was your level of satisfaction in teaching physics at your Community College was? Rank on the likert scale (unsatisfactory, somewhat satisfied, satisfactory, extremely satisfied)

How satisfied would you rate your teaching experiences after attending the PEPTYC Program? (unsatisfactory, somewhat satisfied, satisfactory, extremely satisfied)

After implementation of any ideas from the PEPTYC Program, how satisfied are you with your teaching of physics now? (unsatisfactory, somewhat satisfied, satisfactory, extremely satisfied)

APPENDIX D: Transitions: Modern Physics to Quantum Optics Topics

In recent decades, there has been a great deal of interest in the availability and effectiveness of training for those going into technologically oriented careers. However, much of this interest had focused on students receiving professional training at the baccalaureate level and beyond. Only in the last few years had concern at the highest policy making levels broadened to include the education of those who enter the workforce after one or two years of post-secondary studies. As part of this broadening emphasis, the twenty first century brought about a change in the National Science Foundation (NSF) which established the Advanced Technological Education (ATE) Program within the Directorate of Education and Human Resources. A key aim of the ATE program was to promote science and technology education at the two-year college level. Among the projects funded by the ATE was the "Two-Year College Quantum Optics Advanced Technological Education Program," under the auspices of the Department of Physics at Texas A&M University. Although this project is described briefly here as a separate project, the coordinators and leadership of the project actually viewed this as an extension of their initial PEPTYC I-V grants, hence there was a transition from PEPTYC V, the last of the initial modern physics sequence, into PEPTYC QuOP, also known as PEPTYC VI and VII, also described and documented in this research. This transition was described in the following dialog where the researcher found that the underlying goals of the project were really the same (PEPTYC I-V and Qu-OP PEPTYC VI-VII) and just given some new labels. Since the NSF vision changed, the PEPTYC Project Vision was modified to follow that change.

PEPTYC QuOP: An Extension of PEPTYC

The PEPTYC QuOP project, held its first traditional two-week institute at Texas A&M from May 15 to May 26, 2000, and with this change of title and change of focus it had two main objectives. The first was to expose two-year college physics faculty participants to recent developments in quantum optics technology, giving them a grounding in the principles involved and hands on experience with the new tools of this technology. The second was to enhance participants' familiarity with the new active-learning instructional techniques. The first objective was one that "changed with the times". Again this was because of the NSF vision change, a change that brings us to the present day. The vision statement drafted for the new NSF strategic plan (NSF 2000), stated, "Enabling the nation's future through discovery, learning, and innovation."

By design, this vision captured the dynamism that has shaped NSF's history. According to Joseph Bordogna, of the NSF, during his speech *NSF the first fifty years and the next fifty*, "It's no accident that terms like discovery, learning, and innovations are all resting side-by-side in the same set of words" (1999). While this second major PEPTYC initiative stated its objectives a little bit differently than the original documentation described, it basically outlined workshops and activities that would provide for the pedagogical improvement of two year college teachers within the project. An additional two-week workshop was held the following May, in addition to follow-up workshops at the fall and spring joint meetings of the Texas sections of AAPT and APS. These follow up activities were required, as in the previous projects PEPTYC I-V as described earlier in this dissertation. Since the NSF required a stronger evaluation component to their project awards after the turn of the century, the PEPTYC project leadership subcontracted with the American Institute of Physics' Statistical Research Center to conduct an ongoing evaluation of the PEPTYC Qu-OP program. Brief reviews of the results of that evaluation report were also reviewed as data for this dissertation. The second year of the PEPTYC QuOP cycle was again a parallel program, extremely similar in its format and instructional processes. The second year of the program took a deeper look into the topical applications of Quantum optics as well as a detailed look at applications of Physics Education Research and pedagogical implementations for traditional second semester physics topics.

APPENDIX E: The May Institute

The May Institute ran from Sunday through Friday evening covering 13 calendar days usually starting at 8:15 a.m. and ending at 9:00 p.m. during most week days. The Sunday evening prior to the formal institute was used for check-in, getting acquainted and taking a pre-test on modern physics or some other basic physics content knowledge. Tuesday evenings tended to have special sessions on demonstrations that the participants may use in their classes or for programs in their communities. These demonstration sessions were conducted by visiting physicists recognized for their skill in performing useful demonstrations. Thursday evenings had sessions on repairing and maintaining equipment. These sessions were conducted by Santos A. Ramirez, coordinator for the Texas A & M physics laboratories. The other evenings and the remainder of Tuesday and Thursday evenings were left free to promote interactions among the participants and TYC staff who were living in the same dormitories during the institute. They were also used to produce new products and work on “adaptations” for their own lab projects. The intermediate Saturday was devoted to techniques for using "Physics Olympics" activities to involve students in physics both at their colleges and in their communities. During the second year of the project, this Saturday was devoted to techniques for developing physics contests and tests. The leadership team also suggested procedures for the implementation of such contests and tests in the participant's communities. During one of the final sessions of the institute a post-test on the participant's modern physics or other basic physics content knowledge was given to assess the immediate impact of the project.

The curriculum of the May Institute was designed by the two year college staff to emphasize topics of greatest concern to many two year college physics faculty members. The modern physics topics were originally selected on the basis of regional interest. For example, the Super Colliding Super Conductor (SSC) which at the time, was being created in Texas, helped drive curricular decisions. These faculty needed content background enhancement and potential teaching applications in this modern physics field. The pedagogical topics were chosen for their usefulness in the contemporary introductory physics course. The cracker barrel topics were chosen for their applicability to current issues for two year colleges.

The participants received credit each year for a three hour, graduate level physics course, upon successful completion of the May Institute and Follow-up Workshops. During the initial cycle of PEPTYC this graduate credit was given for a course; Physics 660 - Evolution Physics and, during the second year, credit was awarded for Physics 665 - Concepts of Modern Physics. As the PEPTYC program matured into new and different cycles, the leadership team eventually found ways to offer six graduate credits per year due to the extensive time commitment that was involved in participation in the program. A typical Monday through Friday day time structure is shown in Table 12 below.

Table 12 May Institute Time Line

May Institute Time Line		
8:30- 9:00 a.m.	-	Preview and Sharing Session
9:00- 10:45 a.m.	-	Modern Physics Seminar and Laboratory Experience-Topic I
10:30- 11:45 a.m.	-	Pedagogical Topics - Session I
12:00- 1:00 p.m.	-	Lunch
1:00- 2:15 p.m.	-	Pedagogical Topics - Session II
2:30- 3:45 p.m.	-	Modern Physics Seminar & Laboratory Experience-Topic II
4:00- 5:00 p.m.	-	Cracker Barrel Session
5:00- 7:00 p.m.	-	Dinner Activities
7:00- 9:00 p.m.	-	Open lab or special presentations

Example of the topics and physics research specialists for the modern physics seminars and laboratory experiences for the two years are shown in Table 13 below. These specialists formed a core of peer instructors as well as research scientists who were capable of delivering both content knowledge and pedagogical strategies for the participating members in the project. Table 13 contains an abbreviated list of the peer instructors who eventually participated in the instructional phases of the project.

Table 13 A Sampling of Presenters

Presenters from the May Institute: A Sample
Topic I - Developments in Quantum Optics
Dr. Thomas Walters, Professor of Physics, Texas A & M University
Dr. George Welch, Professor of Physics, Texas A& M University
Topic I - Developments in Condensed Matter, Astrophysics and Cosmology
Dr. Donald G. Naugle, Professor Department of Physics, Texas A & M University
Topic I - Developments in Elementary Particle Physics
Dr. Michael Duff, Professor of Physics, Texas A & M University
Topic II - Microcomputer-Based Laboratory
Mary Beth Monroe, Southwest Texas Junior College
Thomas L. O'kuma, Lee College
Robert A. Tyndall, Fosyth Technical Community College
Topic II - Physics Teaching Models and Physics Education Research
Susie Evers, Panola College
Dwain Deisben, Estrella Mountain Community College
Todd Leif, Cloud County Community College

The seminar phase provided the conceptual developments in the fields; while the laboratory phase provided participants with the opportunities for hands on experiences with some of the instruments and simulations of techniques currently used in each of these fields. Each modern physics block was 1-11/4 hours in length for 20 sessions giving the participants 12-1/2 hours of an experience with each research field, a minimum time commitment to obtain the necessary background for a 1 graduate credit course.

Each cycle was planned by the leadership team and during their planning phases specific topics were chosen for the pedagogical topics. These changed over the various cycles but themes such as the ones in Table 14 below were commonly chosen.

Table 14 Common Topic Themes

The May Institute: Common Topic Themes

1. Quantum physics in introductory physics courses - first year (Last two cycles included Quantum Optics and Laboratory)
2. Computers in physics education - first and second year
3. Use of media in class and laboratory - first year
4. Demonstrations without professional help - first and second year
5. Innovative laboratory experiments - second year
6. Active Learning Models - first and second year

These topics were presented by the project staff with each session being 1-1/4 hours in length. The number of sessions required by each topic varied, depending on the time required to adequately cover the information as determined by the instructor(s).

For example, during the first year, Robert Beck Clark presented the topic on quantum physics in introductory physics. This topical coverage was for 8 sessions (10 hours) and included a foundation coverage of quantum mechanics (Historical, experimental, conceptual, and mathematical), evolution of the Copenhagen interpretation (including coverage of the EPR paradox), and recent developments such as Bell's theorem. Tom O'kuma and a staff member presented the topic on computers in physics education. This topical coverage for the first year was approximately 4 sessions (5 hours) and included basic coverage of computers and computer systems, usage of computers in the lecture, usage of computers in the laboratory, and usage of computers for departmental/administrative matters. Various staff members presented the topic on use of media in the class and laboratory. This included the use of video analysis and later in the program, even applications of the web as a classroom instructional tool. These topical areas were presented in 4 sessions (5 hours) and included basic and innovative uses of emergent A/V materials and computer equipment, and the production of media materials.

Additionally, special staff presented the topic on active learning models. This information was modeled throughout the sessions and included things like the Workshop Physics approach, ICP 21 modeling, Discourse Management, and various forms of Peer Instruction. This topical coverage was specifically discussed for 4 sessions (5 hours) and was included in many of the additional activities as recent results in physics education research, successful models, and ways to implement active learning in the TYC curriculum.

The May Institute was designed to provide the participants with the content background of two modern physics topics each year. It was also designed to provide laboratory activities that might be adapted or developed for use at the participant's home institutions. The initial year of laboratory activities were done to demonstrate what was being done at other institutions and led to discussions for possible implementations elsewhere. During the following academic year, the participants were required to develop "ways" to incorporate some of this information into their own introductory physics courses. The participants also saw a variety of approaches to teaching and using pedagogical topics that they could also choose to incorporate into their introductory physics classes and laboratories.

Cracker Barrel Sessions

Awareness of the teaching world of the two year college professional was a topic that the leadership team of the PEPTYC project deemed extremely valuable and important. Hence, as stated earlier, one of the major parts of the program was the introduction and discussion of significant themes related to two year college instruction, called cracker barrel discussions. The topics chosen for the cracker barrel sessions used during both years of the project are listed in the group of topics in Table 15 below. Many of these themes corresponded to ideas found in other projects such as the Two Year College in the 21st Century project, (TYC 21) which was being developed during the PEPTYC program.

Table 15 Cracker Barrel Discussions

The May Institute: Themes of Cracker Barrel Discussions

1. Articulation with universities
2. Remediation, background materials for Texas Academic Skills Program
3. Textbooks & laboratory manuals - required, recommended and/or reference
4. "Best" ways for presenting introductory physics topics
5. Proposal writing
6. Physics fairs, Olympiads, tests and contests

7. "Best" demonstrations and laboratory experiments
8. Professional development
9. Participant sharing
10. Visiting scientist programs on hot new topics in physics

These topics led to organized discussions in both large group and small break out groups. The sessions were led by the project staff. The coordination of these discussions by the leadership team provided much of the background information necessary for the discussions to be held. Each leader gave out background information or literature that also addressed specific problems or concerns within the two-year college teaching field. General reporting by the participants assisted in the synthesis of the information and conclusions brought about by the various cohorts. The cracker barrel sessions enabled them to better develop a complete physics program at their two-year college and to begin to develop improved interaction with their local community.

A Sample Schedule

A description and example of the PEPTYC program would not be complete with out a sample schedule (See Table 16). Since the Institute was an emersion experience where a number of “samples” from various pedagogical approaches and various peers were being shown, this schedule was generalized from one of the specific years. Participants’ names were omitted while staff and leadership were left as representative. The time scale and the types of activities that are listed were quite typical of the entire 7 cycle process. Some of the time slots were optional in the evenings. The participants were also allowed a little time off over the Institutes’ weekend.

Table 16 General Schedule

May Institute General Schedule

Sunday, May 14

10:00 - 5:00 p.m.	Setup of computers, interfacing and testing of systems
6:00 - 7:00 p.m.	Check-in of participants & staff –TAMU Dorms- Clark
8:00 - 9:45 p.m.	Introduction and orientation- Clark and O'kuma
9:45 - 10:15 p.m.	Final check of equipment and Staff meeting

WEEK 1

Monday, May 15

8:15 - 8:55 a.m.	Evaluator's Survey - O'kuma
9:00 - 10:15 a.m.	Quantum Optics Lecture – Research Professor
10:30 - 11:45 a.m.	Quantum Optics Lecture – Research Professor
12:00 - 1:00 p.m.	Lunch
1:00 - 2:30 p.m.	Introduction to Introductory Physics Curriculum Innovations - O'kuma & Staff
2:45 - 3:30 p.m.	Introduction to Introductory Physics Laboratory Innovations - O'kuma & Staff
3:30 - 5:30 p.m.	MBL Experience - Mechanics, mostly Force and Motion - O'kuma & Staff
7:00 - 9:00 p.m.	MBL Experience - Mechanics - O'kuma & Staff

Tuesday, May 16

8:15 - 8:55 a.m.	Preview and Sharing Session – Participant, Participant & Participant - O'kuma
9:00 - 10:15 a.m.	Quantum Optics – Research Professor
10:30 - 11:45 a.m.	Quantum Optics – Research Professor
12:00 - 1:30 p.m.	Lunch - Tom's Bar-B-Q
1:45 - 2:45 p.m.	Cracker Barrel - "Physics for All Students" – Monroe
3:00 - 4:00 p.m.	Scientific Reasoning and Piagaet – Leif
4:15 - 5:30 p.m.	Training of Future Teachers - Clark, Monroe, and Leif
7:00 - 9:00 p.m.	ATE, Grants & Opportunity - Hehn

Wednesday, May 17

8:15 - 8:55 a.m.	Preview and Sharing Session - Participant, Participant & Participant – Monroe
9:00 - 10:15 a.m.	Quantum Optics Lecture – Research Professor
10:30 - 11:45 a.m.	Quantum Optics Lecture – Research Professor
12:00 - 1:00 p.m.	Lunch
1:00 - 2:15 p.m.	Workshop Physics – Tyndall
2:30 - 5:30 p.m.	Workshop Physics and Technical Physics – Tyndall
7:00 - 9:00 p.m.	MBL Experience - Mechanics, Rotational Motion- Staff

Thursday, May 18

8:15 - 8:55 a.m.	Background Testing - O'kuma
9:00 - 10:15 a.m.	Quantum Optics Lecture – Research Professor
10:30 - 11:45 a.m.	Quantum Optics Lecture – Research Professor
12:00 - 1:00 p.m.	Lunch

1:00 - 2:15 p.m.	"A Non Traditional Institution for Non Traditional Students" – Monroe
2:30 - 3:45 p.m.	"Using CDs in Your Curriculum" - O'kuma and Staff
4:00 - 5:30 p.m.	Cracker Barrel - "Which Text? - Monroe & Staff
7:00 - 9:15 p.m.	Media Experience - Staff

Friday, May 19

8:15 - 8:55 a.m.	Preview and Sharing Session - Participant, Participant & Participant – Tyndall
9:00 - 10:15 a.m.	Quantum Optics Lecture – Research Professor
10:15 - 11:45 a.m.	Quantum Optics Lab – Musser
12:00 - 1:00 p.m.	Lunch - PIZZA DAY (Little Caeser's)
1:00 - 6:00 p.m.	Quantum Optics Lab - Musser/Tweedale

Saturday, May 20

9:00 - 10:15 a.m.	"Peer Instruction" – Clark
10:30 - 11:30 a.m.	Visual Quantum Mechanics - Leif
11:30 - 12:00 a.m.	Quantum Optics Projects - Staff

WEEK 2

Sunday, May 21

6:30 - 9:30 p.m.	MBL Experience - Waves & Sound - Staff

Monday, May 22

8:15 - 8:55 a.m.	Preview and Sharing Session - Participant, Participant & Participant – Leif
9:00 - 11:45 a.m.	Quantum Optics Lab/Making Videos - Musser/Tyndall
12:00 - 1:15 p.m.	Lunch - Chinese (Taste of China)
1:30 - 4:15 p.m.	Making Video/Quantum Optics Lab - Tyndall/Musser
4:30 - 5:30 p.m.	"Video: Other Lab Tools" - Tyndall " - Tyndall & Staff
7:00 - 9:00 p.m.	More on Video - Tyndall & Staff

Tuesday, May 23

8:15 - 8:55 a.m.	Preview and Sharing Session - Participant, Participant & Participant - O'kuma
9:00 - 10:15 a.m.	Quantum Optics Lecture Research Professor
10:30 - 11:45 a.m.	Quantum Optics Lab – Musser
12:00 - 1:00 p.m.	Lunch
1:00 - 2:15 p.m.	Cracker Barrel - "Implementing Change?" – Monroe
2:30 - 3:45 p.m.	"Introduction to Web Materials for the Introductory Course" – Leif
4:00 - 5:30 p.m.	"Web Exploring" - Leif & Staff
7:00 - 9:00 p.m.	Quantum Optics Projects - Staff

Wednesday, May 24

8:15 - 8:55 a.m.	Preview and Sharing Session - Participant, Participant & Participant – Monroe
9:00 - 10:15 a.m.	Quantum Optics Lecture – Research Professor
10:30 - 11:45 a.m.	Quantum Optics Lab – Musser
12:00 - 1:00 p.m.	Lunch

1:00 - 2:15 p.m.	Cracker Barrel - "Measuring Student Outcomes" – Monroe	
2:30 - 3:45 p.m.	"In Classroom Assessment" - Leif, Clark & Staff	
4:00 - 5:30 p.m.	"Some Available Testing & Assessment Tools" - O'kuma	
7:00 - 9:00 p.m.	"Web-Based Assessment" - Leif & Staff	
Thursday, May 25		
8:15 - 8:55 a.m.	Preview and Sharing Session - Participant, Participant & Participant – Tyndall	
9:00 - 10:15 a.m.	Quantum Optics Lecture – Research Professor	
10:30 - 11:45 a.m.	Quantum Optics Lab – Musser	
12:00 - 1:00 p.m.	Lunch	
1:00 - 2:15 p.m.	"The Boundaries of Our Classroom" – Monroe	
2:30 - 3:45 p.m.	"Physics and the Workplace" – Tyndall	
4:00 - 5:15 p.m.	"Integrating Conceptual Tools into the Curriculum" - O'kuma & Staff	
5:30 - 7:00 p.m.	Supper - Golden Corral	
7:15 - 9:15 p.m.	Quantum Optics Projects - Staff	
Friday, May 26		
8:15 - 8:55 a.m.	Background Check - O'kuma	
9:00 - 10:15 a.m.	Quantum Optics Lecture – Research Professor	
10:30 - 11:45 a.m.	Quantum Optics Lab – Musser	
12:00 - 1:00 p.m.	Lunch – Pizza	
1:00 - 2:15 p.m.	Cracker Barrel - "Teaching Scholars " – Monroe	
2:30 - 3:00 p.m.	At-Home Projects & Follow-Up Sessions - Clark & O'kuma	
3:15 - 4:00 p.m.	Evaluation - O'kuma	
4:15 - 5:30 p.m.	Checkout from TAMU and leave for home	

Follow-Up Workshops

In order to maintain the communication links which were forged during the May Institute and to provide further support, continuity and additional materials, the participants were required to attend two follow-up workshops presented by the two-year college staff. For administrative convenience and support, these workshops were held in conjunction with the annual fall and spring meetings of the Texas Section of AAPT. The agenda followed the pattern described in the Table 17 below:

Table 17 Follow-Up Schedule

May Institute: Follow-Up Schedule		
Thursday afternoon	3:00 - 4:15 pm	-Modern Physics Seminar
	4:30 - 5:45 pm	-Pedagogical Topics

	7:30 - 9:30	pm -Cracker Barrel Session
Friday	7:30 - 8:45	am -Discussion of current departmental concerns
	9:00 -10:00	am -Sessions and workshops at TSAAPT meeting
Saturday	9:00 -10:00	pm -Sessions and workshops at TSAAPT meeting

The modern physics seminars and pedagogical topics sessions included a presentation by the two year college staff on suggestions for the inclusion of the May Institute's modern physics topics and pedagogical topics in their introductory physics courses. The cracker barrel session was a one hour discussion led by the project staff on the topics listed in the May Institute section, and a one-hour discussion in which the participants shared what they had done with their "at-home" program. During the spring meeting, a third hour was added to the cracker barrel discussion specifically designed for a second hour of participant experience sharing.

During the first year on the project, the participants attended special sessions and workshops presented at the TSAAPT meetings. At both the Fall and Spring meetings, a session on teaching introductory physics was organized with both invited and contributed papers. At the fall meeting, workshops/sessions on the following topics were offered: making media materials, enrichment of your physics curriculum, and at least one computer usage workshop. At the spring meeting, workshops/sessions on the following topics were offered: organizing and conducting workshops for organizing and sponsoring local physics organizations, writing proposals, and at least one computer usage workshop. These workshops and sessions continued to enhance the participants' exposure to the topics offered during the May Institute. During the second year of the project, the participants also attended further sessions and workshops presented at the TSAAPT meetings. In addition, each participant was expected to present either a paper or a workshop on a topic associated with the project. These are documented in the various reports that were examined by the researcher for this analysis.

At-Home Projects

The final component of the project involved at-home projects that each participant completed during the academic years following the May Institute. This component ensured the implementation of the training received at the May Institute and Follow-up Workshops to practical use at-home. The participants were required to do a minimum of two projects each year of the program. Projects that the participants were required to do were chosen from the following categories as shown in Table 18.

Table 18 At-Home Projects

At-Home Projects Topics

1. Enrichment of curriculum at their colleges
    a. Enrichment of course content in existing physics courses
    b. Enrichment of course offerings to include other recommended courses
2. Workshops given by the participants
    a. Workshops for peers, for TYCs in area, and at meetings of the local physics organizations
    b. Workshops for colleagues at high school, middle school, and elementary schools during in-service programs or as separate functions courses
3. Public presentations
    a. Presentations to community service organizations i.e. Chamber of Commerce, Rotary, PTAs, etc.
    b. Seminars on Science issues "of the day" organized by participants
4. Organizing, sponsoring Physics Olympiads, Fairs, Contests, and Tests
5. Organizing, sponsoring student clubs associated with physics i.e. SPS
6. Establishing partnerships with universities to establish seminars

7. Establishing partnerships with local businesses to establish seminars
8. Writing science columns in local newspapers

Documentation of the work that was done by the participants included both oral and written reports of what each participant was doing "at-home". These oral reports were made at the follow-up workshops during the Fall AAPT meeting and written reports were turned in at the next follow-up workshop corresponding with the Spring AAPT meeting. These were handed into Robert Beck Clark to fulfill the Texas A&M graduate credit requirements. Examples of these reports and projects were analyzed by the researcher and are presented in the Table 19 below.

Table 19: Example Projects from "At-Home"

The development of an interactive computer tutorial program for the laws of electromagnetism.
The creation and execution of a national survey of computer usage at two year colleges.
The development of a suitcase physics program.
The development of instructional materials for accelerator and particle physics for inclusion into an introductory course.
The development of at least three different physics/mathematics integrated programs.
The development of a new laboratory in optics, special courses for technical physics.
The development of curriculum pieces, laboratory activities, and conceptual exercises used for active learning approaches to teaching.