DIFFUSION OF PHOTOVOLTAIC OCCUPATIONAL SKILLS TRAINING: AWARENESS AND ADOPTION IN THE NORTH CAROLINA COMMUNITY COLLEGES.

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ABSTRACT

DIFFUSION OF PHOTOVOLTAIC OCCUPATIONAL SKILLS TRAINING: AWARENESS AND ADOPTION IN THE NORTH CAROLINA COMMUNITY COLLEGES.

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Educational administrators in the North Carolina Community College System (NCCCS) play a key role in the decisions to adopt or reject educational innovations and as a result are the gatekeepers of technology innovations reaching students. In this study the innovation-decision process and other aspects of the diffusion of innovation model are used to consider how the educational innovation of photovoltaic (PV) skills training is diffusing through the NCCCS. The research questions asked how widespread is awareness, how do administrators become aware, how widespread is adoption, and what are the reasons cited for adoption decisions. Subquestions investigated the relationship between awareness and administrator background and college enrollment, adoption and college enrollment, and the relationship between credit and noncredit administrators in the same college. The study collected and analyzed data from two surveys of NCCCS college credit and noncredit (continuing education) administrators and enrollment data.

Over 90% of respondents were generally aware of PV skills training. The awareness rates were lower for more specific knowledge of PV skills training organizations, certifications, and accreditations. News reports, the NCCCS Code Green initiative and Curriculum Improvement Project were most frequently cited as sources of learning about PV skills training. Credit administrators at colleges with larger enrollment were somewhat more likely to have been aware of PV skills training for more time than administrators at colleges with smaller enrollments. Enrollment was not associated with awareness for noncredit administrators. The credit and noncredit administrators at the same colleges learned about PV skills training at different times and in different ways. Administrator background and employment history were not related to awareness.

Adoption was defined as courses offered with PV skills as the primary subject and as PV skills added into the content of existing courses. The reported adoption rates were 21% for PV as a primary skill in credit courses and 35% for noncredit courses. The reported adoption rates were 36% for PV as an added skill in credit courses and 39% for noncredit courses. Credit and noncredit administrators were consistent in the factors they rated as important in their adoption decisions. The reasons cited as very important in the adoption decisions were internal issues of faculty and resources, and external issues of potential employment and requests by area businesses.

Recommendations for future practice include forming a statewide organization of credit and noncredit technology deans to increase the awareness and reduce the time of adoption of new technology training topics, coordinating the credit and noncredit programs introducing new technology topics within individual community colleges, and including credit and noncredit faculty and administrators in future NCCCS technology curriculum improvement projects. Recommendations for future research include a longitudinal study of the implementation and confirmation stages of PV skills training in the NCCCS, examining the relationship between future NCCCS curriculum improvement project activities and awareness and adoption of the curriculum under study, examining the impact of statewide associations of faculty in similar fields and adoption of new technology training, and investigating the interaction of credit and noncredit administrators within individual colleges and across the NCCCS and how the interactions relate to becoming aware of and adopting new technology training programs.

CHAPTER 1: INTRODUCTION

Photovoltaic (PV) system use is increasing in the United States and creating a demand for a workforce with PV occupational skills. Technological advances, environmental concerns, and governmental economic incentives have increased the number of PV systems generating electricity in the United States. The demand for a locally sourced workforce trained in PV technical sales, installation, and maintenance is growing with the installed PV capacity. However, these new workforce skill requirements are beginning to diffuse into technical education in the community colleges, but not all colleges are aware of the need or have decided to adopt PV educational programming. The diffusion of innovation model is used to understand how community college educational administrators become aware of PV workforce skills and which factors are important in the decision to adopt PV educational programming.

The purpose of the current research is to understand the factors related to PV educational programming decisions, including awareness of the need for and the adoption of PV skills training in community college technical educational programming. The following research questions guided this study:

1. How widespread is awareness of PV skills training required for occupations impacted by PV?
2. How do credit and noncredit educational leaders become aware of PV skills training?
3. How widespread is the adoption of PV skills training?

4. What information do credit and noncredit leaders cite as important in their decision to adopt PV educational programming?

Subquestions investigated the relationship between awareness and administrator background and college enrollment, adoption and college enrollment, and the relationship between credit and noncredit administrators in the same college. Quantitative data were collected from databases and two surveys. A representative sample of the credit and noncredit (continuing education) administrators responsible for technical education in the 58 North Carolina community colleges were surveyed.

Significance of the Topic

Growth of Photovoltaic Generated Electricity

There are increasing references to an emerging green economy and the creation of green jobs in the media and literature (Slaper & Krause, 2009; Stone, 2010). The green economy advocates believe there is evidence of global temperatures rising and suggest this is due to the increase of carbon dioxide in the atmosphere from the burning of fossil fuels beginning in the early 1900s. There is continuing debate on the issue of whether the changes in the amount of carbon dioxide in the atmosphere are a natural or man-made phenomenon, what impact the increasing carbon dioxide has on rising worldwide temperatures, and what if anything can or should be done about the increase (Dessler & Parson, 2010). Even with conflicting views, concepts promoting a green economy are diffusing into American society and advocates are promoting the development of education and policies for the green economy. Albeit still changing, the definitions of the green economy and green jobs guide government policy, research funding, business investment, and hiring decisions (Slaper & Krause, 2009). The Pew Charitable Trust

(2009) established the following definition: "A clean energy economy generates jobs, businesses and investments while expanding clean energy production, increasing energy efficiency, reducing greenhouse gas emission, waste and pollution, and conserving water and other natural resources" (p. 5). The Pew definition considered the supply side (rather than users) and broke down the clean energy economy into categories related to clean energy generation, energy efficiency, environmentally friendly production, conservation and pollution mitigation, and training and support. The training and support category includes technical skills instruction for workers in these categories.

Clean energy generation is the largest category by job count and solar energy generation makes up 62% of all clean energy generation jobs (The Pew Charitable Trust, 2009, p. 18). Global PV power capacity increased from 0.1 GW in 1992 to 14 GW in 2008. PV is increasingly viewed as a partial solution to the growing global demand for energy and as a method of reducing the environmental problems associated with existing carbon-based energy (International Energy Agency [IEA], 2010, p. 8). The IEA (2010) estimated that the relative PV share of the total global electricity generation will increase from less than 1% in 2010 to 5% in 2030 and 11% in 2050 (pp. 3, 5, 14). Four countries make up 85% of the 2008 PV generation total: Germany leads the world with 5.3 GW, followed by Spain with 3.4 GW, Japan with 2.1 GW, and the United States with 1.2 GW (IEA, 2010, p. 10).

Grid-connected PV installations in the United States have grown significantly since 2000, with a cumulative installed capacity of 2.15 GW_{dc} in 2010 (Sherwood, 2011, p. 4). The increase is influenced by state and federal financial incentives and the decreasing price of PV cells (North Carolina State University, n.d.). The PV installations are at utilities, residential sites, government buildings, military bases, and retail stores. California had 28% of the 2010 market share, followed by New Jersey at 15%, and Nevada with 8%. North Carolina was ninth with three percent (Sherwood, 2011, pp. 4-8). In 2007 North Carolina passed a law requiring investor-owned utilities in North Carolina to meet up to 12.5% of their energy needs through renewable energy resources or energy efficiency measures (Renewable Energy and Energy Efficiency Portfolio Standard, 2007).

As the number of PV installations increase, so does the demand for workers with PV-related skills. In the United States there were more than 100,237 solar workers in 2011, and the demand for solar workers is expected to rise 24% in the next 12 months (The Solar Foundation, 2011, p. 4). PV-related occupations expected to have the fastest growth over the next year are photovoltaic installers, electricians with specific experience in solar installations, sales at wholesale trade firms, sales representatives or estimators at installations firms, and roofers with specific experience in solar installations. Employers report difficulty hiring qualified workers in these occupations in the United States and in Europe (The Solar Foundation, 2011, p. 13, 16). Governmental, professional, and educational organizations enhance the operational quality and consistency of PV systems by creating qualifications and credentialing for PV technicians and accreditations for educational providers. Establishing career pathways and credentialing for traditional students and older displaced workers is recommended to meet the increasing demand for a qualified PV workforce (White, Dresser, & Rogers, 2010, p. 33). PV technical educational programs will be required to train the workforce for the career pathways and to prepare for credentialing.

Training the PV Workforce

PV use and applications are evolving and so are the training skills required of the PV workforce. Education, government, and professional associations do not agree on PV job definitions, skills required, or workforce training needs (White et al., 2010), but some trends are emerging. The North American Board of Certified Energy Practitioners (2011) has created certifications based on job task analyses for PV installers and for PV technical sales. PV workforce training is developing in two different ways: as an add-on to construction trades such as electricians with additional training in PV, and as stand-alone PV specialists (Ventre & Weissman, n.d.). Community colleges are responding to these needs with a wide variety of credit and noncredit PV training options.

Some community colleges have added PV training courses to existing associate, diploma, and certificate credit programs. In other cases, community colleges have created specific degrees to prepare a PV workforce to become photovoltaic installers (National Solar Jobs Census, 2010, p. 44). Ventre and Weismann (n.d.) found a preference for continuing education to train for specific work skills such as the noncredit courses offered at community colleges (section 5.8). The continuing education departments of universities, solar equipment manufacturers, and utility companies also offer similar noncredit courses. Professional accreditations for training organizations and professional credentials for PV workers have been created to meet the demand for quality assurance of PV training (Interstate Renwable Energy Council, 2011).

Conceptual Framework

The diffusion of innovation model provides a framework for considering how educational administrators become aware of the need for new technical skills training and the factors influencing their adoption decisions for the training (Rogers, 2003). When businesses adopt new technologies, the current and future employees are required to learn new technical skills. Existing employees can acquire the new skills through formal and informal job training by the employer or acquire the skills independently through an outside educational provider. Businesses can develop new training or work with educational partners to develop the new training. Those who require new technical skills can prepare by attaining credit and noncredit credentials. The community colleges are the most widely accessible public source for technical training and credentials. Community college educational administrators must become aware of the need for new technical skills training before making the decision to adopt the training. The community college educational administrators' process of awareness of the technology training need and the decision to adopt new technical training can be viewed through the diffusion of innovation model.

An innovation is an idea new to an individual or group. The diffusion of innovation model describes the process of becoming aware, reviewing, and making a decision to adopt or reject an innovation. The model details a five-stage innovation-decision process: knowledge, persuasion, decision, implementation, and confirmation (Rogers, 2003, p. 170). Communication channels and the decision makers' relative position within the social system are factors influencing each stage of the innovation-decision process. Individuals move through the innovation-decision process at varying rates and may be characterized as innovators, early adopters, early majority, late majority, or laggards depending on the length of time required for an adoption decision (pp. 282-285).

The diffusion of innovation model has been applied to a wide variety of fields including anthropology, sociology, public health, communication, marketing, geography, and education (Rogers, 2003, pp. 44-45). Implications of the diffusion of innovation model for educational programming include the following: educational administrators go through awareness-decision process, administrators will take differing amounts of time to move through the process, and different types of information influence awareness and adoption decisions at different stages of the process (Borrego, Froyd, & Hall, 2010, p. 186).

Curriculum is defined as both an entire course of study and as group of courses making a special field of study (“Curriculum,” 2011). Lattuca and Stark (2009) proposed a curricular model incorporating both definitions. The curricular model defines curriculum as an academic plan made up of purpose, content, instructional resources, instructional processes, and assessment. The academic plan operates within a sociocultural context consisting of internal and external influences acting on the academic plan (Lattuca & Stark, 2009, pp. 4-11). The internal influences are composed of students, faculty, and other constituents. The external influences include new technologies, market forces, societal trends, government policies, and professional societies. The internal and external influences are part of the overall social system through which communication of potential innovations are transmitted and received by administrators.

Educational administrators become aware of, interpret, and make decisions about changes to the academic plan through the innovation-decision process. Curricular innovations are the result of the adoption decisions made by educational administrators through the interaction with the internal and external forces over time. Individual faculty, faculty groups, and educational professionals are internal forces creating individual course content and programs of study. External forces interact with the internal forces and communicate new concepts and ideas for curriculum content. Educational administrators go through the innovation-decision process and become aware of and make decisions to adopt or reject the innovations (Rogers, 2003, p. 189).

The diffusion of innovation model and specifically the innovation-decision process informs our understanding of how community colleges educational administrators become aware of and decide to adopt innovative educational curricula. The innovation-decision process describes the innovation awareness and adoption processes occurring in stages. Educational administrators gain knowledge and become aware of educational innovations by many methods of communication about the innovation, including word-of-mouth, technical and nontechnical presentations, national technology and employment trend reports, state-level models, and local needs analysis (Austin, 1989; Borrego et al., 2010; Kolatis, 1988). Administrators consider the importance of the new knowledge and consider factors such as resources and faculty to make an adoption or rejection decision.

Implications of the staged model of innovation-decision process include, for example, an administrator identified as an innovator or early adopter should expect few peers in the early acceptance of an educational innovation and might consider identifying early majority adopters to act as peer counselors to influence adoption decisions by others. Educational administrators might plan different sources and types of communication on curricular innovations to move their organization through the innovation decision-making process faster. For example, mass media is important for early adopters, and interpersonal networks are more important to late-majority adopters (Rogers, 2003, pp. 211-212). Educational administrators might provide mass media on national or state trends to make others aware of the innovation. Communicating that others in a social system, such as community colleges in another state, are adopting a new curriculum may be a method to speed the awareness and adoption of a new curriculum.

The diffusion of innovation model has been applied to understand the adoption of innovations in public and higher educational settings. Carlson (1965) studied the relationship between public school superintendents' characteristics and their adoption of innovations such as modern math. Lawton and Lawton (1979) developed a mathematical model for the diffusion of educational innovations and applied it to the study of adopted practices in public schools such as modern math and team teaching.

Borrego, Froyd, and Hall (2010) applied the diffusion of innovation model to evaluate the awareness and adoption of engineering education innovations in four-year college and university programs. Dougherty (2003) studied the different rates of adoption of employee training for business by community colleges. Sahin and Thompson (2006) used the diffusion of innovation model to study faculty adoption of instructional computer use. Computer science is an example of technology diffusion into education and other sectors of society.

Computer science is an example of a technology innovation that diffused into the community college curriculum beginning in the 1960s. In 1969 a national report from the American Association of Community Colleges suggested two-year computer instruction programs be established to meet the demand for programmers in the computer industry (Hill & Sedrel, 1969). In 1975, the Washington State Board for Community College Education researched the patchwork of instructional computing curriculum across the state and presented a model state-level plan for curriculum, facilities, and staff training for instructional computing for Washington state junior colleges (Howard, 1975). In the 1980s a research report from Princeton University on designing a computer curriculum for community colleges noted computer technology was moving from mainframes to desktop personal computers, and the need for data processing skills was growing rapidly (Kolatis, 1988, p. 1). In the late 1980s, individual colleges assessed their computer-related curricula's relevance to the still evolving technology and job market (Austin, 1989). The pattern of the diffusion of computer science curriculum over more than 20 years appears to be national reporting of the needs, followed by state-level needs analyses suggesting model curricula, and later the development of college facilities and staff training. Local college level reports followed with more details of the local needs of business and industry, students, and state mandates.

The information used by educational administrators changed over time from a national broad technology trend reports, anticipated employment needs and professional society recommendations, to state-level needs, and finally locally focused needs for the technology and match with college mission (Austin, 1989; Kolatis, 1988, pp. 2-11). The willingness of the college to adopt computer science curriculum was influenced by the senior leadership support, physical resources needed, and the faculty staffing required (Kolatis, 1988, p. 11). One additional factor in the continued diffusion of computer technology into community college curriculum was the speed of the technology change, which was equal to or greater than the time required to change the curriculum (Kolatis, 1988, p. 11).

Statement of the Problem

Grid-connected PV installations in the United States have grown significantly since 2000, requiring new PV workforce skills within existing occupations and new occupations. These new workforce skill requirements are beginning to diffuse into technical education in the community colleges, but not all community colleges are aware of the need or have decided to adopt PV educational programming. To understand why there is this discontinuity, an understanding of the current degree of awareness and adoption and the relative importance of influencing factors on awareness and adoption of PV educational programs by educational administrators is needed. Previous research has been reported on adoption of PV by utility personnel but has not been extended to community colleges educational administrators.

Purpose and Research Questions

The purpose of the current research is to understand the factors related to PV educational programming decisions at community colleges, including how credit and noncredit educational administrators become aware of the need for PV workforce skills training and what factors are important in their decisions to adopt PV skills training. The following research questions guided this study:

1. How widespread is credit and noncredit community college administrators' awareness of PV skills training for occupations impacted by photovoltaics?

a. Is there a relationship between awareness and administrator background?

b. Is there a relationship between how many years since administrators in the same college learned about PV skills training?

c. Is there a relationship between administrator awareness and college enrollment?

2. How do credit and noncredit college administrators become aware of PV skills training?

a. Is there a relationship between how administrators in the same college become aware?

b. Is there a relationship between how administrators and college enrollment?

3. How widespread is adoption of PV skills training into credit and noncredit community college programs?

a. Is there a relationship between adoption and college enrollment?

4. What sources of information do credit and noncredit administrators cite as important in their decision to adopt PV skills training?

a. Is there a relationship between information cited as important for adoption by credit and noncredit administrators at the same college?

b. Is there a relationship between information cited as important for adoption and college enrollment?

Research Methodology

The diffusion of innovation model was used to design a research study to collect investigate educational administrators' awareness and adoption of PV skills training. The diffusion of innovation model was used to interpret and analyze the results and discuss how innovative technical educational topics might be more readily diffused to the educational administrators making curriculum adoption decisions.

A quantitative, cross-sectional survey research design was used to collect data at a single point in time from individual educational administrators on the awareness and adoption of PV into credit and noncredit educational programming. The survey questions considered how educational administrators became aware of the innovation and what information was important in their adoption decisions. Additional archival data on adopted courses were collected from the North Carolina Data Warehouse on the semester and year of the credit and noncredit courses receiving full time equivalencies (FTE). College websites and online catalogues were reviewed to collect data on the credit and noncredit programs offering PV courses. The online data were triangulated with the survey and archival data.

Delimitations of the Study

The current research is limited to credit and noncredit educational leaders in the North Carolina community colleges involved in making administrative adoption decisions on technology-related educational programs. Although other community college personnel are involved in considering and evaluating educational programming, the intermediate administrators understand and have access to information on community, institutional, and student needs that faculty and other staff at the colleges may not have access to.

The research is further bounded by consideration of PV technologies impacting technician-level workers. The impact on engineers and policy makers is not considered because most of these occupations require a four-year degree. The research studies only the North Carolina community colleges. Comparisons between states are not made because of the different state laws governing the post-secondary educational systems and the different educational financing models. Other sources of PV training are not included because they are not as widely available or as low cost as the community college educational programming.

The study is a cross-sectional, one point in time view of PV programming. There may not be enough data to review multiple years of history of PV educational programming as the field is new to the community colleges and because adding educational programs may take up to a year to implement. The addition of PV concepts into existing courses could be verified by reviewing the specific course syllabi and from qualitative data from the instructors, but this is outside the scope of the current research.

CHAPTER 2: LITERATURE REVIEW

The purpose of the literature review is to further explore and provide clarification of the factors related to educational administrator curriculum innovation decisions. The application of the diffusion of innovation model is used to guide and focus the review. This chapter also provides a picture of the current status of PV use, summarizes occupational skills needed to support PV use, and discusses the history and current state of awareness and adoption of PV-related skills training in community colleges.

Theoretical Framework

Community colleges increasingly prepare the current and future mid-skilled workforce for jobs requiring the use of advanced technologies (Bragg, 2002). Community college administrators make decisions about adding new curricula, based on their awareness and understanding of the need for the training to meet student and employer demands (Dougherty, 2003, p. 80). The diffusion of innovation model analyzes factors related to how educational administrators become aware of and make adoption decisions for new and innovative curricula. Diffusion of innovation models consider different aspects of learning about, reviewing, and making a decision to adopt an innovation. Straub (2009) reviewed three of the most cited innovation diffusion and adoption models applied in educational research: Rogers' diffusion of innovation model (Rogers, 2003), concerns-based adoption model (Straub, 2009), and the technology acceptance model (Legris, Ingham, & Collerette, 2003).

All three models assume a common definition of innovation as something new to an individual or group (Rogers, 2003, p. 12). Straub (2009) described Rogers' (2003) model as foundational for understanding adoption across a wide range of disciplines, but found the model itself not easily applied to specific adoption studies (Straub, 2009, p. 627). The concerns-based adoption model has been applied to study curriculum change and technology change, where technology is most often defined as instructional computer use. The technology acceptance model has been applied to study computer based information technologies. Straub noted all of the adoption-diffusion models “have an implicit proadoption bias” (p. 628). Each of the three models provides a somewhat different perspective of the innovation awareness and adoption process. The concerns-based adoption and the technology acceptance models were developed relatively recently and are tightly focused on technology as computer-related topics. Rogers’ (2003) diffusion of innovation model has been the most broadly applied to different types of innovation decisions in a wide range of fields including sociology, education, psychology, geography, and medicine. The breadth of the Rogers model and the large body of research applying and further developing the model make it the most applicable innovation diffusion model to non-computer related topics.

Rogers’ (2003) Diffusion of Innovation Model

The core of Rogers’ (2003) diffusion of innovation model is the five-stage innovation-decision process shown in Figure 1 (p. 170).

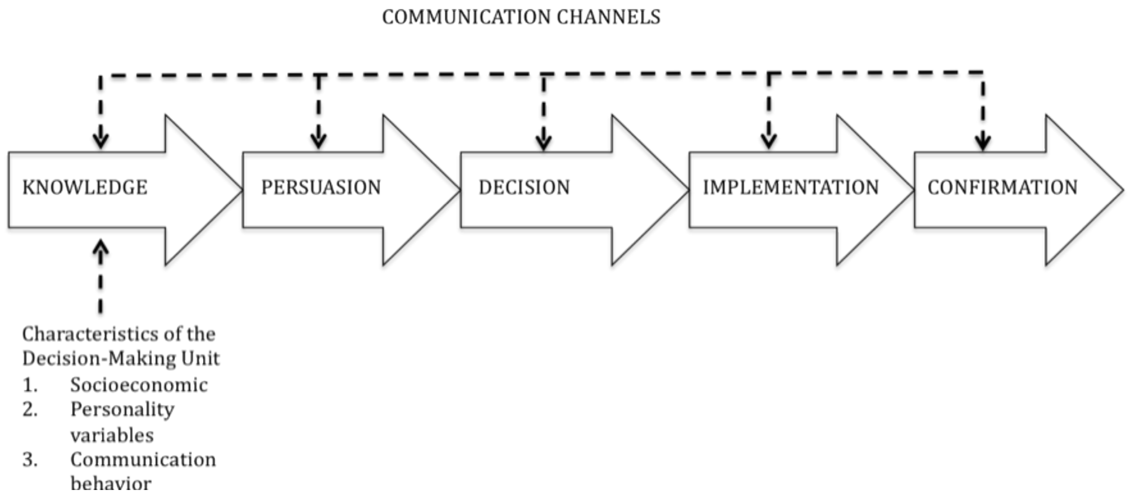

Figure 1. The innovation-decision process. Source: *Diffusion of Innovations, Fifth Edition* by Everett M. Rogers (Fig. 5-1, p 170).

Stages of the innovation-decision process are defined as follows:

- *Knowledge* occurs when an individual (or other decision-making unit) is exposed to an innovation's existence and gains an understanding of how it functions.
- *Persuasion* occurs when an individual (or other decision-making unit) forms a favorable or an unfavorable attitude towards the innovation.
- *Decision* takes place when an individual (or other decision-making unit) engages in activities that lead to a choice to adopt or reject the innovation.
- *Implementation* occurs when an individual (or other decision-making unit) puts a new idea into use.
- *Confirmation* takes place when an individual seeks reinforcement of an innovation-decision already made, but he or she may reverse this previous

> decision if exposed to conflicting messages about the innovation. (Rogers, 2003, p. 169)

Rogers (2003) framed the stages of the innovation-decision process with communication channels influencing each stage of the process. Rogers identified prior conditions and characteristics of the decision-making unit that influence the initial knowledge stage. He also described how the perceived characteristics of the innovation enter the second, persuasion stage of the process. The decision to adopt or reject is the made in the third stage. The fourth and fifth stages occur after the adoption decision has been made and consider how the innovation is implemented and confirmed.

There are three types of stage one knowledge: awareness, how-to, and principles. Awareness knowledge can be attained passively or through direct action. Awareness alone does not result in any further action. Awareness of an innovation may be preceded by a need for the innovation. Change agents create awareness of new innovations and assist others in understanding the specific benefits of the innovations. Individuals with earlier knowledge of an innovation than others have more education, higher social status, more exposure to mass media channels of communication, more exposure to interpersonal channels, and more contact with change agents (Rogers, 2003, pp. 171-174). Factors of formal education, position, types of media exposure, and amount and extent of personal interactions about innovations also influence innovation awareness. Understanding the role of these factors is important in studies of innovations early in the diffusion process.

In stage two, persuasion, a positive or negative attitude toward the innovation is formed. Individuals in the persuasion stage are influenced by feelings about the innovation itself. An individual may seek more information, decide about credibility of the information, and develop a perception of the innovation. At this stage the characteristics of the innovation are considered: relative advantage, compatibility, complexity, trialability, and observability. An individual will evaluate the specifics of the innovation to his or her individual situation and may be influenced by the opinion of peers (Rogers, 2003, pp. 174-177).

In the third stage, decision, the innovation is adopted or rejected. Most individuals want to try or observe the innovation on a limited basis before making a decision. Trials or demonstrations of the innovation or receiving positive reports from a peer may positively influence adoption decisions. The innovation may be actively or passively rejected. The social culture around a decision maker may also impact the decision (Rogers, 2003, pp. 177-179).

The fourth and fifth stages, implementation and confirmation, occur over a period of time after the innovation has been accepted. The innovation may change or evolve during the implementation stage. After implementation, an individual may seek to confirm the adoption decision (Rogers, 2003, pp. 179-190).

The majority of diffusion studies are historical with data collected at one point in time, usually after the innovation has been adopted (Rogers, 2003, 127). Although possibly losing some of the details of the innovation-decision process development over time, these studies are still valuable for analyzing the factors that led to the adoption or rejection of an innovation.

Findings of Previous Diffusion of Innovation Research

Diffusion studies in the last 65 years have correlated the adoption rate of a single innovation by an individual or an organization with quantitative data about and from individual and organizational adopters at a single time after diffusion has taken place (Meyer, 2004). Diffusion of innovation research has studied the perceptions of adopted innovations, communication methods, and the role of social systems (Sahin & Thompson, 2006). Quantitative data on the characteristics of the adopters and their perceptions of the innovation have been collected using surveys and the data analyzed to explain the time of adoption of the innovation (Sahin & Thompason, 2006, p. 60). Other studies have investigated the way adopters were informed, their motives, their perceived barriers, and the role of social networks in the adoption decision (Jager, 2006). Fewer studies have researched the interplay of the individual and organizational issues on adoption of innovations (Meyer & Goes, 1988; Sahin & Thompson, 2006).

Carlson (1965) studied the relationship between public school superintendents' characteristics and their adoption of innovations such as modern math. He found adopters had a tendency to

> (1) be younger, (2) know well fewer of their peers, (3) be sought less often for advice, (4) receive higher professional ratings, (5) exhibit greater accuracy in the judgment of their rates of adoption of innovations, (6) have a shorter tenure in their present position, and (7) seek advice and information from more person outside the local area. (p. 65)

Lawton and Lawton (1979) developed a mathematical model for the diffusion of educational innovations and applied it to the results of Carlson's study. Their model fit many of Carlson's innovation data and it could also be used to extrapolate data to predict the life cycle of the innovation (pp. 34-40). Dougherty (2003) studied the different rates of adoption of employee training for business by community colleges. He found the major factors influencing adoption to be employer skill demand, administrative leadership, fiscal and human resources available to develop and market curricula, equipment training facilities, and staff training (p. 85). Sahin and Thompson (2006) used Rogers' (2003) diffusion of innovation model to study faculty adoption of instructional computer use. They found computer expertise, computer access, barriers to computer access, attitude towards computer use, support for computer use, and adopter categories based on innovativeness were significantly correlated with the level of computer use by faculty (p. 91).

An organization's decision to adopt new innovations is influenced by personal interactions (Borrego et al., 2010), size of the organization (Mohr, 1969), employer skill demand, administrative leadership, fiscal and human resources available to develop and market curricula, equipment training facilities, and staff training (Dougherty, 2003). It is important to consider combinations of these factors such as economic projections for technology and actual business demand for skills (Slaton & Ebeling, 2010). Borrego, Froyd, and Hall (2010) applied the diffusion of innovation model to evaluate the awareness and adoption of engineering education innovations in four-year college and university programs. The researchers described how department chairs became aware of the engineering education innovation and the factors important to their decision to adopt the engineering education innovation. The overall awareness rate of the engineering educational innovations (82%) was much greater than the adoption rate (47%) (Borrego et al., 2010, pp. 194-197). They reported the most common method of awareness was word-of-mouth followed by presentations on campus or at non-technical society conferences. The adoption decisions were most influenced by the availability of resources to implement, student resistance, and faculty willingness to adopt (Borrego et al., 2010, pp. 197-199). Mohr's (1969) study of diffusion of innovation in public agencies, which follow similar processes as public education, found the size of the organization was the strongest predictor of innovation adoption, possibly because size indicated the resources available (p. 126).

Kaplan (1993) studied how electric utility managers became aware of PV in the early 1990s, at the first stages of awareness of PV technology by the industry. He created a more detailed model of the first two stages of Rogers' (2003) innovation-decision model. Kaplan expanded the first two stages into a multifaceted model renaming Rogers' stage two persuasion as "interest." He also added variables of motivation, context, experience, and familiarity to the expanded model to explain the dependent variable of interest (Kaplan, 1993, p. 52). Kaplan found the independent variables accounted for 50% of the variation in interest (Rogers' stage 2 persuasion). He concluded in the early stages of the innovation-decision process, familiarity has the greatest influence on interest but at later stages, technical knowledge was more important (Kaplan, 1993, p. iv). Kaplan defined familiarity as comfort and confidence in the technology based on both experience and technical knowledge (pp. 103-104). Kaplan's technical knowledge was defined as Rogers' how-to and principles knowledge (p. 102). Kaplan found technical knowledge was more important in the decision to adopt PV for early innovators and early adopters, while familiarity is a "critical link in predicting interest" for those who have not yet made the decision to adopt (p. 317). He suggested early PV utility adopters were interested in and acted on analysis of the technical facts of PV, and that the same technical facts did not cause later adopters to make the same decisions. Instead the later adopters' decision making was more influenced by "…promoting trial and error, groping along, experiential learning, success stories, 'doing the doable', and generally making decisions explicitly *not* by formal analysis and technical, objective assessment of factors" (Kaplan, 1999, p. 326). Kaplan's study is an example of how the diffusion of innovation model can be applied to PV-related topics.

Aspects of the diffusion of innovation model inform the understanding of the educational program planning of community colleges as administrators learn about, review, and consider whether to add to existing credit and noncredit programs or to create entirely new programs to support PV add-on and stand-alone occupations. The decision to adopt PV skills training into the community college technical education system is influenced by factors external and internal to the community college. The external factors include the state of PV research and development, federal and state legislative and economic support, business and industry skill demand (Dougherty, 2003), and worldwide PV applications. Internal factors related to awareness and adoption of new innovations include personal interactions (Borrego et al., 2010), size of the organization (Mohr, 1969), administrative leadership, fiscal and human resources, and equipment training facilities, and staff training (Dougherty, 2003). The diffusion of innovation model and related technology diffusion research provides additional insights into the process of curricular innovation for PV technology education in the community college.

Curriculum Innovation

Educational administrators go through the innovation-decision process when considering curricular innovations. Community colleges are increasingly expected to provide the training for the current and future skilled workforce (“President’s State of the Union Address,” 2012). Community college administrators learn about the skills needed by business and industry and lead efforts to develop curricula to provide students with those skills. Technological advanced change the required skills, and community college administrators modify existing curricula or create new curricula to meet the new skills requirements. The process of curriculum change is a human process of educational administrators becoming aware of innovations and making decisions about the curriculum content.

Curriculum can be defined as either “All the courses of study offered by an educational institution” or “A group of related courses, often in a special field of study…” (“Curriculum,” 2011). Lattuca and Stark (2009) proposed a curricular model, applicable to both definitions, as an academic plan in an educational environment located within a larger sociocultural context shown in Figure 2. The sociocultural context includes internal and external influences acting on each other and with the educational environment. The curriculum model acknowledges the two-way interaction of the internal and external influences acting on the academic plan, as well as the academic plan acting on the internal and external influences. There is a feedback loop from the academic plan, to educational outcomes, to internal and external influences, back to the academic plan. The curriculum model is useful for examining the role of internal and external influences on the innovation-decision process of the educational administrators making curricular decisions.

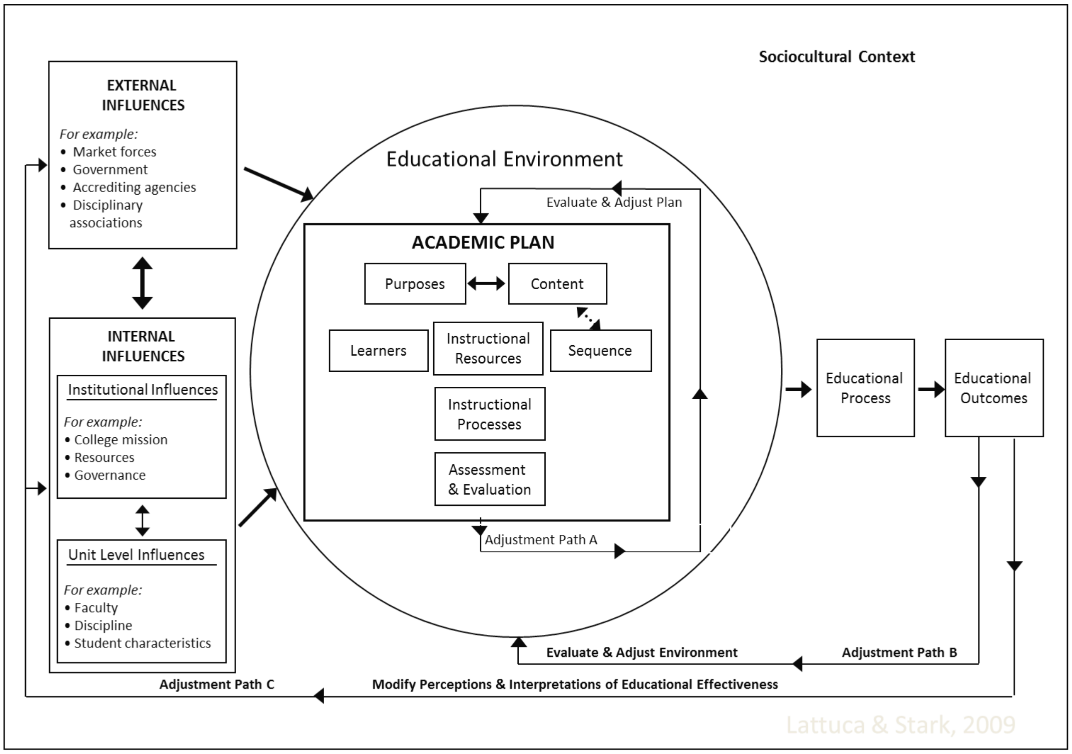

Figure 2. The academic plan in a sociocultural context. From *Shaping the College Curriculum: Academic Plans in Context* (p. 24), by L. S. Lattuca and Joan S. Stark, 2009, San Francisco: John Wiley & Sons, Inc. Copyright (2009) by John Wiley & Sons, Inc. Reprinted with permission.

The academic plan. Lattuca and Starks' (2009) academic plan includes eight elements: purposes, content, sequence, learners, instructional processes, instructional resources, evaluation, and adjustment. Within the academic plan the purposes are defined as the intended outcomes of the curriculum. The content is the subject matter and sequence is the order in which the subject matter is arranged. The learners are the students with a variety of preparation and interests for the content. Instructional processes are the methods of instruction used by the instructors and the instructional resources are the materials and setting used with the instructional processes. The outcomes of the instructional processes are assessed, evaluated, and adjusted to better meet the intended purpose, closing the loop on the academic plan (pp. 4-11). Adopting curricular innovation require new instructional resources, facilities, faculty and training.

The internal and external influences on the academic plan are inputs to the awareness stage of the innovation-decision process. Educational administrators are subject to internal and external influences on the academic plans and make decisions based on their interpretations and reactions to these influences (Lattuca & Stark, 2009, p. 301). Time, although not explicitly stated, is another dimension impacting the academic plan in the Lattuca and Stark (2009) model. The results of the internal and external forces may be difficult to discern or may be contradictory over the short term. The influence of the internal and external forces may be easier to see over the longer term as the initial contradictory patterns smooth out into longer-term trends (Lattuca & Stark, 2009, p. 301).

Lattuca and Stark's (2009) external influences are characterized as influences in society that interact with and change the student, faculty, and other constituent demands on content in educational institutions. Technological trends such as the computer and Internet technologies are examples of external influences significantly impacting the development of new programs and changing the content of existing programs. External influences can also include market forces such as the labor market, societal trends, and government policies and actions (p. 12-13). Worldwide events, governmental legislation, professional society standards, and private foundations also exert influence on the curriculum.

The creation of the land-grant universities is a historical example of market and governmental external forces influencing the creation of new curricula. Educational administrators at public universities created new content areas in agriculture and engineering after external legislation established land-grant universities (Lattuca & Stark, 2009, p. 305). The addition of sustainability into college curriculum is a more modern example of external influences driving curricular change (Stubbs & Schapper, 2011).

Internal influences on curriculum include institutional-level and unit-level influences (Lattuca & Stark, 2009, pp. 13-14). The institutional-level influences include the college mission, resources, and governance. The unit-level influences include the faculty and administrators within the educational institution. For example, educational administrators such as deans, associate deans, and chairpersons are internal influences on the response to program evaluations and will direct potential changes to educational content, instructional resources and faculty recruitment (Lattuca & Stark, 2009, p. 14).

Educational decision making about curricular innovation. Educational administrators are responsible for developing and evaluating programs of study. Individual faculty, faculty groups, educational professionals, or professional associations create programs of study and course content. The educational administrator, while not creating content, goes through an awareness process and makes the decision to adopt new curriculum. The innovation-decision process outlines the steps an educational administrator goes through while considering an innovation: knowledge or awareness, persuasion, decision, implementation, and confirmation (Rogers, 2003, p. 189).

The educational administrator becomes aware of an educational innovation from internal and external sources to the educational institution from multiple communication channels. The administrator gains an understanding of the innovation and forms a positive or negative attitude towards the innovation. Multiple factors impact the administrators' decision such as perceived importance, instructional resources and faculty skills. The administrator then makes a decision to accept or reject the innovation.

Current Status of PV and Related PV Occupational Skills

Photovoltaic system use is increasing in the United States and creating a demand for a workforce with PV related skills. PV systems are a renewable source of electricity in a world increasingly concerned about energy creation and use. PV costs have decreased, legislation has been passed to mandate electric companies produce a percentage of their energy from renewable sources and financial incentives have made PV more accessible to individuals and businesses. Businesses have been created around the design, application, and installation of PV. They are increasingly looking for a workforce with skills in the PV technology. Educational administrators responsible for workforce development are also learning about the PV skills required and are creating new PV training courses or modifying existing training courses by adding PV skills.

Photovoltaics as a Renewable Energy Source of Electricity

The energy source used to generate electricity has changed over time. Waterpower was originally the primary source for generating electricity. As the demand for electricity grew, electric power generation companies needed additional sources of energy to generate electricity. There was a diffusion process of awareness and adoption as the companies creating and selling electricity transitioned from one power source to another. The electric power companies began using carbon-based sources such as coal, and later natural gas and petroleum, as fuels to create steam to power electric generators (Nye, 1991).

Carbon-based fuels, also known as fossil fuels, have become the major source of electricity today. The increased use of carbon-based fuels has been associated with the growth of carbon dioxide emissions into the atmosphere. Increased carbon dioxide has been associated with an increase in global temperatures and climate change (Intergovernmental Panel on Climate Change, 2012, p, 7.) Issues of debate include whether the changes in the amount of carbon dioxide in the atmosphere is a natural or made phenomenon, what impact the increasing carbon dioxide has on rising world wide temperatures, and what if anything can or should be done about the increase (Dessler & Parson, 2010). Dressler and Parson (2010) noted, “One of the most striking aspects of this debate is the intensity of disagreements expressed over what we might expect to be simple matters of scientific fact, such as whether the Earth is warming and whether human emissions are responsible” (p. 6). Climate discussions and disagreements are present in the media, scientific literature, and among citizens. These are some of the external factors acting upon educational administrators deciding what educational content is appropriate for their students. Although there is still debate over the long-term impact of the increased carbon dioxide in the atmosphere from burning fossil fuels, electric utility companies are experimenting with noncarbon-based renewable energy sources such as wind and the sun as energy sources to generate electricity.

Increased PV-generated Electricity

The technology for using renewable resources such as the sun to create electricity has been available since the 1950s. PV technology has been more expensive and the cost of the electricity generated more expensive than the electricity produced with carbon-based energy sources. As a result, PV has been used only where no other source of electricity was available, for example in satellites. When nonrenewable sources of electric power became less available, more expensive, and known for negative environmental effects, PV was reconsidered as source of electricity in the United States and around the world (Dunlap, 2010).

Solar radiation or sunlight, the raw material for PV-generated electricity, is available everywhere on the earth. PV research and development is ongoing and has resulted in many new PV materials and applications (Parida, Iniyan, & Goic, 2011). The cost of PV cells continues to decrease as manufacturing efficiencies increase and new materials and applications are added. PV-generated electricity is now available in many countries around the world. Global PV power capacity has grown from 0.1 GW in 1992 to 14 GW in 2008 and is increasingly viewed as a partial solution to the growing global demand for energy and as a method of reducing the environmental problems associated with existing nonrenewable carbon-based energy. The International Energy Agency (IEA) estimated that the relative PV share of the total global electricity generation will increase from less than 1% in 2010 to 5% in 2030 and 11% in 2050 (IEA, 2010, pp. 3, 5, 14). Four countries make up 85% of the 2008 PV generation total: Germany leads the world with 5.3 GW, followed by Spain with 3.4 GW, Japan with 2.1 GW and the United States with 1.2 GW (IEA, 2010, p. 10).

More recent data show grid-connected PV installations in the United States doubled in 2010 from 2009 levels, to a cumulative level of 2.15 GW_{DC} (Sherwood, 2011, p. 4). The increase was influenced by state and federal financial incentives and the decreasing price of PV modules (Sherwood, 2011, p. 4). Thirty-nine percent of the installations were non-residential, 32% were utility generated, and 29% percent were residential. The utility share has grown from essentially 0% in 2006 to 32% in only four years. The non-residential share includes government buildings, retail stores, and military installations (Sherwood, 2011, p. 6). California had 28% of the 2010 market share, followed by New Jersey at 15% and Nevada at 8%. North Carolina was ninth in market share with three percent (Sherwood, 2011, p. 8).

Media and literature increasingly reference an emerging green economy and the creation of green jobs (Slaper & Krause, 2009; Stone, 2010). The attempt to define and promote a green economy and green jobs is supported by international efforts such as the United Nations Environmental Programme (United Nations Environmental Programme, 2009) and the awarding of the 2007 Nobel Peace Prize to Al Gore and the Intergovernmental Panel on Climate Change "for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change" (Nobelprize.org, 2007). The definition, albeit still changing, of the green economy and green jobs guides government policy, research funding, business investment and hiring decisions (Slaper & Krause, 2009). The “Clean Energy Economy” report by the Pew Charitable Trust (2009) defined a clean energy economy as one that “generates jobs, businesses and investments while expanding clean energy production, increasing energy efficiency, reducing greenhouse gas emission, waste and pollution, and conserving water and other natural resources” (p. 5). The Pew report definition considered the supply side (rather than users) and divided the clean energy economy into categories related to clean energy generation, energy efficiency, environmentally friendly production, conservation and pollution mitigation, and training and support. The training and support category included technical skills instruction for workers in these categories. Clean energy generation is the largest category by job count and solar energy generation makes up 62% of all energy generation jobs (Pew Charitable Trust, 2009, p. 18).

Federal and state policies promoting renewable energy are being considered or have been adopted. The 2009 federal stimulus bill included incentives for clean energy (The Pew Charitable Trust, 2009, p. 7). The goal of the U.S. Department of Energy SunShot Initiative is to make electricity generated from PV cost competitive with other forms of energy ("SunShot Initiative," n.d.). The National Renewable Energy Laboratory (National Renewable Energy Laboratory, n.d.) is researching the next generation of energy technologies. A wide variety of federal and state financial incentives (North Carolina State University, n.d.) promote PV use.

Increased Demand for a PV Workforce

The increase in the PV demand in the United States creates expanded need for a workforce with PV skills training. In the United States there were more than 93,000 solar workers in 2010 and the demand for solar workers is expected to rise 26% in the next 12 months (The Solar Foundation, 2011, p. 5). The National Solar Job Census considered solar workers in installation, wholesale trade, manufacturing, and other categories for PV and solar hot water. Eighty-two percent of the firms in the study reported wholesale trade in PV (The Solar Foundation, 2011, p. 26). PV component manufacturing is international, but PV installations are local and create a demand for locally sourced PV workers. PV-related occupations expected to have the fastest growth over the next year are photovoltaic installers, electricians with specific experience in solar installations, sales at wholesale trade firms, sales representatives or estimators at installations firms, and roofers with specific experience in solar installations. The demand for qualified workers in these occupations is greater than the current supply in the United States (p. 13) and in Europe ("Solar Photovoltaic Employment in Europe," 2009, p. 16). Governmental, professional, and educational organizations enhance the operational quality and consistency of PV systems by creating qualifications and credentialing for PV technicians. Establishing career pathways and credentialing for traditional students and older displaced workers is recommended to meet the increasing demand for a qualified PV workforce (White et al., 2010, p. 33).

Photovoltaic Workforce Training

PV workforce training is relatively new and there is not a master listing of courses published by a national training or governmental organization. There is a list of trainers and training organizations accredited by the Interstate Renewable Energy Council (IREC) (Interstate Renewable Council, 2012). The IREC accreditation is based on job task analyses by the North American Board of Certified Energy Practitioners (NABCEP). The IREC accreditation has been attained by many organizations nationally.

Education, government, and professional associations have not reached consensus on PV job definitions, skills required, or workforce training needs (White et al., 2010), but some trends are emerging. The PV workforce is being trained in two different ways: as an add-on to construction trades such as electricians with additional training in PV, and as stand-alone PV specialists. In a survey of licensed contractors, PV practitioners, administrators, and expert instructors, the majority of respondents reported that the "added skills approach" was the most useful in markets beginning to experiment and try

PV, as compared to the most experienced markets such as California that preferred solar specialist specific training (Ventre & Weissman, n.d., section 5.3).

Add-on training for PV. Public and private training organizations have added PV training to their existing training programs by adding specific PV courses in traditional curricula and by integrating PV skills into existing courses. Community colleges have added PV training courses into their associate degree and certificate programs. For example, Lane Community College (Oregon) includes PV design and installation as one course in the Associate of Applied Science degree in the Energy Management Technician major (Lane Community College, n.d.). Oakland Community College (Michigan) includes a course entitled "Solar Energy Systems for Heat and Electricity" in the Renewable Energies and Sustainable Living certificate (Oakland Coummunity College, n.d.). The degree of PV skills integrated into existing courses has not been studied.

PV training is an added unit of the National Joint Apprenticeship and Training Committee (NJATC) apprenticeship, journeyman, and electrical contractor levels training ("About the NJATC," n.d.). The NJATC is sponsored by the International Brotherhood of Electrical Workers (IBEW) and the National Electrical Contractors Association (NECA). The NJATC have their own training centers for union members and their PV training is considered a model for PV installers (Ventre & Weissman, n.d., section 4).

Stand-alone training for PV specialists. Public and private organizations have also added stand-alone credit and noncredit training to develop PV specialists. The United States Department of Labor's Occupational Information Network (O*NET) defined four new PV related occupations in 2009: solar energy installation managers, solar energy systems engineers, solar photovoltaic installers, and solar sales representatives and assessors (Dierdorff, Norton, Drewes, & Kroustalis, 2009; "O*NET Online," n.d.). Workers in these occupations may be trained specifically for these occupations rather than as an add-on skill to another occupation. Businesses employing PV installers include residential remodelers, roofing contractors, and electrical contractors (The Solar Foundation, 2011, p. 44). A large number of PV installations use non-union tradesman and require a widely distributed source of local training to meet the growing demand. Ventre and Weissman (n.d.) found a preference for continuing education to train for specific work skills such as continuing education offered at community colleges (section 5.8). In North Carolina, Central Piedmont Community College's website lists a five-day noncredit continuing education course, "Solar Photovoltaics for the New Clean Energy Economy" ("ENV 7200," n.d.). Continuing education departments of universities, solar equipment manufacturers, and utilities offer similar noncredit courses.

PV professional accreditation and credentialing. The increasing amount of add-on and stand-alone PV training has created the need for credentialing. Professional accreditation for training organizations and professional credentials for PV workers have been created to meet the demand for quality assurance of PV systems. Professional organizations such as The North American Board of Certified Energy Practitioners (NABCEP) have developed PV Installer and PV Technical Sales certifications to "raise industry standards and promote consumer confidence" (North American Board of Certified Energy Practioners, n.d.). The Institute for Sustainable Power Incorporated created the ISPQ International Standard 01022, "General Requirements for Trainers and

Training Programs Offering Renewable Energy, Energy Efficiency, or Distributed Generation Training," to accredit training organizations such as community colleges, businesses and private consultants (Interstate Renwable Energy Council, 2011). A few of the NJACTC training centers, community colleges, and other training organizations are accredited to the ISPQ standard 01022.

Community Colleges Provide Credit and Noncredit Training

Education can provide a link between school instruction and work skills (Swinney, 2001). The occupational skills required by the workforce change as businesses evolve to meet competitive demands. Jobs requiring technology have increased and in 2009, 86% of technology workers have some college education, up from 63% in 1973 (Carnevale, Strohl, & Smith, 2009, p. 21). Sixty-five percent of credential-seeking sub-baccalaureate students are in career education curricula preparing students for entry level positions in the work force. Additional students are enrolled in noncredit programs to update workplace skills. Credit and noncredit educational programming addresses the training for new occupational skills. Community colleges offer credit degree programs at the associate, diploma, or certificate levels. Career and technical credit degree programs are offered by many community colleges in a variety of fields impacted by PV, including building construction and electrical technologies.

Community colleges also offer a wide variety of noncredit training in areas including skill and workforce development, transfer credit programs and courses, professional education, and general interest courses (Downey, Pusser, & Turner, 2006, p. 77). Workforce development and professional education are most closely tied to upgrading work skills and preparing students for skilled trade careers. Noncredit courses may provide a training certificate and prepare students for an industry recognized credential where a credit degree is not required.

Community College Credit and Noncredit Educational Programming Strategies

Community college educational administrators use informal and formal environmental scanning to identify the needs from external sources for new or updated credit and noncredit programming. Informal processes include community interactions with government, education, business, and political organizations to learn about the needs of the community (Boone, Safrit, & Jones, 2002, pp. 112-114). Formal processes include reviewing national reports, state legislation, and advisory boards. Advisory boards made up of local businesses and industries are used for environmental scanning (Hirschy, Bremer, & Castellano, 2011). Community college educational administrators ask representatives from area businesses about the workforce skills required of their employees. The community colleges educational administrators use the skills identified in the informal and formal scanning as the basis to update or create credit and noncredit programs to meet established and new community and business workforce needs. Larger, established business are often long-term community college partners and help the college to identify changing skills required of new and existing employees. Many of the businesses using PV occupations are newer and smaller organizations. For example, the average solar installation firm employs eight workers (The Solar Foundation, 2011, p. 5). These smaller businesses may not be part of the traditional informal or formal environmental scanning of the community colleges. Educational administrators may not be aware of or interact with these smaller high technology employers and, as a result, may not be exposed to the needs of these employers or even be aware of the increasing use of the technologies.

Community College Administrator Awareness and Adoption of PV Occupational Skills

National interest in PV and other renewable energy sources increased in the 1970s prompted by oil shortages (Dunlap, 2010, pp. 3-12). Community colleges became aware of the need for PV educational programming in the 1970s and 1980s and were influenced by federal incentives and optimism about the future of PV and solar hot water (Dutton & Hooper, 1980; Green & Orsak, 1979; Seaman, 1981; Ward, 1979). Colleges grappled with the placement of new training in their curriculum considering if solar-related training was a new and separate field, or if it was an extension of an existing curriculum. Southern Illinois College conducted a feasibility study for an alternative energy technology program and concluded that the alternative energy program should be created as a unit within an existing program at the college (Blair, 1984). After the oil shortage ended, the interest in PV and other renewable energy sources decreased in the United States. Government funding and focus on solar was reduced or eliminated. Few jobs that required PV skills were created and little PV training was offered at community colleges.

There are major differences between this first awareness of the need for PV education in the 1970s and 1980s, and the awareness of the need for adoption of PV technical training in 2012. In the 1970s and 1980s, the cost of PV was very high, there were few government incentives, and there was limited understanding of the potential harmful impacts of the green house effect. PV educational training in the 1970s and 1980s was an educational innovation motivated by communication through national reports on the potential of PV and other renewable resources. The 1970s and 1980s can be viewed as the beginning of a 40- or 50-year period in which PV awareness and adoption were building very slowly. Today awareness and adoption are increasing because of a new social system, decreasing costs, and increased national security issues.

Alternative energy, including photovoltaics, is one of the many sustainable practices and training areas being adopted in higher education. The Association for the Advancement of Sustainability in Higher Education (n.d.) is an example of an organization promoting sustainability practices and training in higher education. The American Association of Community Colleges organized a web-based resource, the Sustainability Education and Economic Development Center (SEED, n.d.). The SEED strategic plan is founded on the idea that the green economy is coming and that community colleges are integral in the training required to support the green economy:

> The clean energy and green economy presents an unprecedented opportunity to grow American prosperity. Billions of dollars stand to be generated and saved by using energy and other resources more wisely, drawing on non-polluting energy and material sources that never run out, and otherwise developing our world with a commitment to sustainability. (SEED, n.d.)

PV training is one of the many areas community colleges offer to support the SEED strategic plan. PV training includes credit and noncredit training, offered in stand-alone curricula and as skills integrated into traditional curricula. The PV programs listed on the site range from noncredit certificates to two-year associate degree programs.

There are a growing number of organizations providing training to community college instructors. The U.S. Department of Energy (2011) sponsors the Solar Instructor

Training Network. Hudson Community College (New York) hosts the Northeast Region of the Solar Instructor Training Network, and 24 community colleges have participated in the training (U.S. Department of Energy, 2011).

Summary

PV is a new technology used to generate electricity in the United States and around the world. PV residential and utility installations are increasing and creating a demand for a workforce to install and maintain the installations. Employers are having difficulty hiring qualified PV workers. Community college administrators are becoming aware of the demand for PV skills training and are beginning to adopt PV skills training courses. Administrators are also becoming are of PV skills training certifications and accreditations created by national organizations to provide quality assurance for the training programs.

The diffusion of innovation model has been used to examine innovations in a variety of fields including education and the model provides a framework to consider the diffusion of PV skills training into the community college technical training curricula. A curriculum model adds to the understanding of how forces inside and outside the colleges influence the academic plan created by the administrators to provide the technology training.

CHAPTER 3: METHODOLOGY

The purpose of the current research is to understand the factors related to PV educational programming decisions, including the awareness of the need for and the adoption of PV skills training into the technical educational programming of community colleges. The following research questions guided this study:

1. How widespread is credit and noncredit community college administrators' awareness of PV skills training for occupations impacted by PV?

    a. Is there a relationship between awareness and administrator background?

    b. Is there a relationship between the number of years since administrators in the same college learned about PV skills training?

    c. Is there a relationship between administrator awareness and college enrollment?

2. How do credit and noncredit community college administrators become aware of PV skills training?

    a. Is there a relationship between how administrators in the same college became aware?

    b. Is there a relationship between how administrators became aware and college enrollment?

3. How widespread is adoption of PV skills training into credit and noncredit community college programs?

    a. Is there a relationship between adoption and college enrollment?

4. What sources of information do credit and noncredit administrators cite as important in their decision to adopt PV skills training?

a. Is there a relationship between information cited as important for adoption by credit and noncredit administrators at the same college?

b. Is there a relationship between information cited as important for adoption and college enrollment?

Chapter Three describes the methodology used in the current research. A survey research design (Creswell, 2005) was used to collect quantitative data on the awareness and adoption of PV skills in technical education in the North Carolina Community College System (NCCCS) colleges. Quantitative data were collected from the NCCCS Data Warehouse and a cross sectional web survey. The sampling frame was North Carolina community college educational administrators responsible for credit and noncredit education program areas impacted by PV applications. The diffusion of innovation model was used as the theoretical framework to conceptualize the design of the current study.

Theoretical Framework

Rogers' (2003) diffusion of innovation model was used as the theoretical framework to conceptualize the design the current study. Rogers' model as described in his book *The Diffusion of Innovation* is the most influential model in diffusion of innovation research (Straub, 2009, p. 629). Rogers' diffusion of innovation model encompasses factors impacting all diffusion stages, the innovation-decision process, attributes of innovations and their rate of adoption, innovativeness and adopter categories, diffusion networks, the role of change agents, innovation in organizations, and consequences of innovations. The innovation-decision process is the core of the model and the focus of the current research. It is the process of becoming aware of, learning more about, and making a decision to adopt or reject an innovation. The five stages of the innovation-decision process are knowledge, persuasion, decision, implementation, and confirmation (Rogers, 2003, p. 170). The current research is focused on the first and third stages of Rogers' five-stage innovation-decision process, knowledge and decision, as shown in Figure 3.

Figure 3. Portion of the steps in Rogers (2003) innovation-decision process used in current research. "Knowledge" renamed as awareness.

The following are Rogers' (2003) definition of the stages:

- *Knowledge* occurs when an individual (or other decision-making unit) is exposed to an innovation's existence and gains an understanding of how it functions.
- *Decision* takes place when an individual (or other decision-making unit) engages in activities that lead to a choice to adopt or reject the innovation. (p. 169)

Rogers (2003) defined three types of knowledge: awareness, how-to, and principles. Awareness precedes the other types of knowledge. The focus of the current study is on awareness knowledge, and the term "awareness" is used throughout. Table 1 lists the awareness and decision stages of the process and how they are related to the innovation of PV educational programming. Awareness was studied by collecting data on general awareness of PV skills training, specific awareness of PV training organizations, skills certifications and accreditation, and how administrators learned about the need for PV educational skills training.

The decision stage is composed of an adoption or rejection decision (Rogers, 2003, pp. 177-179). The current research focuses on adoption decisions. Rejection decisions are also important but are more difficult to measure. Adoption was defined as courses where PV skills were the primary subject and courses where PV skills were added into existing courses.

Table 1

How the Awareness and Decision Stages of Rogers' Innovation-Decision Process Are Investigated for PV Educational Programming

Innovation-Decision Process Stages	Definition for PV in the NCCCS	Related Research Question (RQ)
Knowledge - Awareness	Have heard of PV skills training for workers in occupations impacted by PV and level of familiarity with PV skills training programs, PV skills training certifications and PV skills training accreditation.	RQ1 – How widespread is credit and noncredit community college administrators' awareness of PV skills training for occupations impacted by photovoltaics?
	Personal and businesses, professional interactions, publications, and other information on PV educational programming.	RQ2 – How do credit and noncredit administrators become aware of PV skills training?
Decision - Adoption	PV educational programming taught as a primary subject or added to another course where PV skills training is not the primary subject.	RQ3 – How widespread is adoption of PV skills training into credit and noncredit community college programs?
	Source of information cited as important in adoption decision.	RQ4 – What sources of information do credit and noncredit administrators cite as important in their decision to adopt PV skills training?

An understanding of the factors related to the awareness and adoption of educational programming to support new technologies such as PV will assist colleges in their awareness and adoption processes for educational programming to support new occupational skills related to changing technology.

PV Skills Training Educational Innovation

The educational innovation investigated is the addition of PV skills training into credit and noncredit educational programming at colleges in the NCCCS. In North Carolina, Central Carolina Community College and Central Piedmont Community College were early adopters of the PV skills training educational innovation. Central Carolina Community College developed the ALT credit course prefix, which was adopted by the NCCCS for several additional courses including an introductory alternative energy course and biodiesel courses (A. McMahan, personal communication, July 14, 2011). Central Piedmont Community College later developed the AAS Sustainable Technology Degree program and created several additional ALT courses including ALT 220 Photovoltaic Systems Technology and ALT 221 Advanced Photovoltaic Systems Designs (A. McMahan, personal communication, July 14, 2011). Central Piedmont Community College also created a noncredit course, EGY 3002 Photovoltaic Technology. ALT 220 and ALT 221 became effective and available for community colleges statewide to offer in the 2009 fall semester. The description of each credit and noncredit course is shown in Table 2.

Table 2

NCCCS Credit and Noncredit Photovoltaic Courses in the Common Course Library

Academic Level	Course Title	Course Description
Credit		
ALT 220	Photovoltaic Systems Technology	This course introduces the concepts, tools, techniques, and materials needed to understand systems that convert solar energy into electricity with photovoltaic (PV) technologies. Topics include site analysis for system integration, building codes, and advances in photovoltaic technology. Upon completion, students should be able to demonstrate an understanding of the principles of photovoltaic technology and current applications (3credits).
ALT 221	Advanced Photovoltaic Systems Design	This course introduces specific elements in photovoltaic (PV) systems technologies including efficiency, modules, inverters, charge controllers, batteries, and system installation. Topics include National Electrical Code (NEC), electrical specifications, photovoltaic system components, array design and power integration requirements that combine to form a unified structure. Upon completion, students should be able to demonstrate an understanding of various photovoltaic designs and proper installation of NEC compliant solar electric power systems (3 credits).
Noncredit EGY 3002	Photovoltaic Technology	This course provides instruction on the fundamentals of photovoltaic systems. Students will learn design criteria, installation, safety issues, and maintenance of photovoltaic systems, construction skills, and applied math skills. Upon completion, students will have the knowledge base for an entry-level position with a dealer/installer or other photovoltaic industry company (Maximum hours 252).

Note. Course descriptions from North Carolina Community College System. (2012b). *Combined course library*. Retrieved from http://www.nccommunitycolleges.edu/ccl.htm

The NCCCS maintains a common course library of the state-approved credit and noncredit courses. Colleges may offer only specific credit courses approved by the state. The title, credit hour, contact hours, and content outline for credit courses are fixed and common across the 58 North Carolina community colleges. Every college adopting a credit course uses the same title, content, and credit hours. The letter, number designations, and title of noncredit courses can vary by each college in order to allow customization to meet the needs of the local colleges.

Study Context, Population, and Sampling Frame

The study was based in the NCCCS. The NCCCS initiated a two-year, statewide curriculum improvement project (CIP) in August 2010 with the goal of adding sustainability concepts to the credit curricula in the sectors of building construction, engineering, energy, transportation, and environmental technologies. The project, known as Code Green Super CIP*,* was one of several projects of the overall Code Green Initiative. The Code Green Initiative is a special project of the North Carolina Community College Presidents Association ("CODE GREEN Initaitive," n.d.). A few colleges added sustainability concepts into their educational programs before the Code Green Super CIP began. A statewide inventory of sustainability-related educational training and other activity at the 58 North Carolina Community Colleges was completed in April of 2009. The survey documented a wide variety of sustainability-related credit and noncredit courses being offered or in development (M. Meyer, personal communication, November 16, 2011). PV skills training was one of many different sustainability concepts identified in the survey.

The population for the survey was all credit and noncredit educational administrators responsible for building construction, engineering, energy, industrial systems, and sustainability curricula at the 58 North Carolina community colleges. The division deans or department chairs of the vocational technical departments were determined to be the best source of information from this population because of their position responsibilities overseeing the development, scheduling, and evaluation of specific curricula (McArthur, 2002, pp. 257-258). In the North Carolina community colleges, the vocational technical deans and department chairs' titles often include a reference to technology such as "Applied Technology." Deans and chairs are frequently involved in the development and scheduling of courses, evaluating the enrollment trends, interfacing with advisory boards and the community, and receiving feedback from students. Borrego et al. (2010) found that department chairs at baccalaureate institutions were the "optimal target group for dissemination activities" on engineering educational innovation (p. 190). Borrego et al. found department chairs were not the adopters or opinion leaders, but they were the most knowledgeable of both the technical content and curriculum decision making on engineering educational innovations. Borrego et al. also found identifying the department chairs as the survey respondents reduced the possible self-selection bias of using faculty members as the target of the study. Department chairs at community colleges have similar responsibilities as those at baccalaureate institutions. The title of the position with these responsibilities at community colleges vary by community college. Larger community colleges have a wider range of titles for department chair level positions. Smaller colleges have fewer positions managing technical programs and the administrator over the technical programs targeted may be a vice president or other title.

The sampling frame was the first level of credit and noncredit educational administrators responsible for recommending and implementing curriculum changes for building construction, engineering, electrical, industrial and sustainability technology at the 58 North Carolina community colleges. These areas were selected because they represent the content areas of technical education impacted by PV and are the majors of the students most likely to go onto occupations impacted by PV. The sampling frame was two administrators (one credit, one noncredit) from each of the 58 colleges for a total of 116. The individuals in the sampling frame were identified by a website review, an email request from the Haywood Community College president's assistant to the presidents' administrative assistants at the 57 other North Carolina Community Colleges, and direct email and phone calls to college faculty and staff. A screening question was also used at the beginning of the survey to confirm that the respondent fit the definition of the sampling frame. The target response rate for the Internet survey was 50% for the credit and 50% for the noncredit of the 58 NCCCS colleges (Dillman, Smyth & Christian, 2009). The sample is described in Chapter Four.

Instrumentation

Survey Instruments

Quantitative data on awareness (RQ1), how administrators became aware of PV skills training (RQ2), adoption data (RQ3), and what sources of information administrators cite as important in their decision to adopt PV skills training (RQ4) were gathered from the surveys. One survey was created for credit administrators and one survey was created for noncredit administrators.

Survey contents. Other survey instruments used in innovation diffusion studies were reviewed for possible application. Several instruments have been designed to measure the perceptions of the attributes based on Rogers' (2003) five attributes of innovations, and adoption of informational technology (IT) innovations. Moore and Benbasat (1991) created and validated a 38-item instrument to study the relationship of the perception of the innovation to the adoption of IT innovations within organizations. Atkinson (2007) created a 30-item instrument to study the perceived attributes of technology-based health education innovation. Pankratz, Hallfors, and Cho (2002) created a 17-item survey to study the relationship between Rogers' five attributes of an innovation and the adoption of the innovation, for a federal drug prevention policy. These instruments provided general guidance on diffusion of innovation instrumentation but were focused on the perception of the educational innovation while the current research is focused on different aspects of the model, the innovation-decision process.

Other instruments have been designed to measure Rogers' (2003) five-stage innovation-decision process. Kaplan (1993) created a survey to test an expansion of the Rogers innovation-decision model, to study familiarity and adoption of photovoltaic electricity production by electric utility managers. Steckler, Goodman, McLeroy, Davis, and Kock (1992) developed six questionnaires to study the diffusion of innovative health programs on tobacco prevention in junior high schools. Two of the six questionnaires, "Awareness-Concern" and "Rogers's Adoption Variables," were based on Rogers' innovation-decision model. Borrego et al. (2010) created a survey based on Rogers' innovation-decision model to study the awareness and adoption of engineering education innovations.

The Borrego et al. (2010) research was the most closely related to the current research because it considered higher education and introduction of educational innovations into the educational settings and some of their survey questions were adopted. Aspects of the Kaplan (1993) and Stecker et al. (1992) questionnaires, specifically on measuring aspects of the awareness stage of Rogers' (2003) innovation-decision model, were adapted for this instrument.

The researcher constructed two Internet-based surveys. One survey was created for the credit educational administrators (see Appendix B). The second survey was similar but worded for the noncredit administrators (see Appendix C). If one administrator was responsible for both the credit and noncredit areas under study, the administrator was asked to fill out both surveys. Filtering questions were used to determine if the respondent had adopted the innovation. The surveys included questions on respondent demographics, PV skills awareness and adoption, how the respondent became aware of the innovation, and what factors were important in their decision to adopt the innovation.

Demographic items included the survey respondents' position title, years in this role, years at the community college, total years of employment, and highest degree earned. Awareness was measured by four survey questions on when the respondent first heard about PV skills training, familiarity with PV skills training providers, and familiarity with PV skills training certifications and accreditations. Educational administrators may be aware of PV skills training and not be aware of the specific training providers, certifications, or accreditations. Any response other than “This is the first I have heard of it” was recorded as being aware of PV skills training. Awareness of specific PV training programs, certifications, and accreditations were evaluated from the questions on familiarity with PV skills training, PV skills training certifications, and PV skills training accreditations.

A survey question asked how the respondent first heard about the need for PV technical training. Possible responses included reading, presentations, other education, business professionals, and word of mouth. Factors identified as important in their decision to adopt included funding, outside inputs, internal inputs, and personal interactions. Adoption for credit courses where PV was the primary subject was measured by the North Carolina Community College Data Warehouse data for ALT 220 and ALT 221. Adoption for credit courses where PV was an added skill was measured by survey questions asking if PV added skills courses had been offered and in what subject area. The noncredit respondents were asked if PV primary and PV added courses were offered and for the name of the noncredit course if known. Additional data for the noncredit PV primary course adoption was gathered from the North Carolina Data Warehouse for EGY 3002. EGY 3002 is the only noncredit course in the Common Course Library with PV as the primary subject. The data from the Data Warehouse were considered valid and reliable because of the source from the North Carolina Community Colleges.

Validity and Reliability Evidence

The validity of the survey responses was increased by having the surveys reviewed by a panel of technical experts, pretested by credit and noncredit administrators using the think-aloud process, and pilot tested. The expert panel consisted of four PV skills training experts in the NCCCS. The experts reviewed the surveys for clarity and accurate measurement of the variables. The panel reviewed the instructions, response alternatives, navigational elements, and wording and evaluated whether the questions included all the possible variations of PV technical training in the NCCCS. The survey was modified to correct missing or unclear content. The validity of the survey responses was also increased by using the think-aloud method with one credit administrator and two noncredit administrators from the NCCCS not included in the sampling frame (Ercikan, Arim, Law, Domene, Gagnon & Lacroix, 2010; van Someren, Barnard, & Sandberg, 1994). Additional information was added to the definition of terms, additional options were added to questions, and navigation errors were corrected. The majority of changes were made uniformly in the credit and the noncredit surveys. A few specific changes were made to the credit and noncredit wording and options to use terminology more familiar to the credit and noncredit respondents. For example, the noncredit administrators identified themselves as “continuing education” because they awarded “credit” in the form of nonacademic certificates of completion. The noncredit survey was changed to use the term “continuing education” instead of “noncredit” throughout the survey.

Validity was also improved by piloting the survey with two community colleges, one in Tennessee and one in South Carolina. The pilot group found the survey questions to be clear and only minor changes were made. The survey was administered in a standard manner to strengthen validity. Validity was also increased by asking an open-ended question at the end of the surveys for additional information and clarification.

Reliability was assessed for the stability and consistency of the survey results. Two credit respondents completed the surveys twice. The first and second survey responses from the respondents were correlated and a statistical score determined. The dichotomous agreement was 1.00, and the ordinal agreement was 0.66 for exact agreement and 0.08 for adjacent agreement. One noncredit administrator took the survey twice. The dichotomous agreement was 0.89, and the ordinal agreement was 0.57 for exact agreement and 0.30 for adjacent agreement.

Enrollment and Archival Data

Enrollment and archival adoption data about the colleges were collected from the NCCCS research office. Enrollment data collected was the total 2010-11 enrollment for credit and noncredit areas for each college. Credit and noncredit college enrollment records from the North Carolina Community College website for the year 2010-2011 were evaluated (North Carolina Community College System, 2012a). The enrollment total for associate, diploma, certificate, and transfer was used for the curriculum enrollment. The occupational category of continuing education was selected for comparison because PV skills training for occupations impacted by PV are recorded under this category. The enrollment for the Occupational Regular Budget Program and the Occupational Self-Supporting Program were combined for the noncredit enrollment total for the 2010-11 year. The North Carolina Community College (2012a) 2010-11 Annual Statistical Reports defines the Occupational Regular Budget programs as "…extension courses that consist of single courses, each complete in itself, designed for the specific purposes of training an individual for full- or part-time employment, upgrading the skills of persons presently employed, or for retraining others for new employment in occupational fields." The Occupational Self-Supporting Programs are defined as "…occupationally related courses which the college may provide at the request of the community but for which the college receives no budgetary credit. The cost of such activities is borne exclusively by the participants or some contracting agency" (North Carolina Community College System, 2012a).

Adoption data (RQ3) were measured from the archival enrollment data documented in the NCCCS Research and Performance Management Data Warehouse on the credit courses ALT 220 and ALT 221 and the noncredit course EGY 3002 since 2009. The enrollment data included the college name, semester, year, and number of students recorded attending the ALT 220, ALT 221, and EGY 3002.

Data Collection Methods

Surveys have evolved from face-to-face verbal questioning, to postal mail paper-based and returned questions, to telephone verbal questions, to Internet respondent controlled web-based surveys (Dillman et al., 2009, p. 243). Researchers increasingly use the Internet to conduct surveys because email has become the accepted and expected form of business communication and because it can reach more people more quickly. The Internet provides a fast and inexpensive method of to distribute and collect data from the surveys (Dillman et al., 2009).

Survey response rates can be increased by including personalization, sending a token of appreciation with the survey request, using multiple contacts with different looks and appeals, strategically timing contacts, and by establishing procedures ahead of time for handling potential problems. Personalization includes using the recipients' name and using official stationary from the researcher's organization. Token financial incentives of a few dollars in cash have been shown to increase response rates for most populations (Dillman et al., 2009). Dillman et. al. (2009) suggested a sequence of five contact formats: pre-notice letter, questionnaire mailing, thank you postcard, replacement questionnaire, and a final contact by a different mode of delivery from the previous contact (p. 243). Strategic timing considers the timing of concern to the recipients such as holiday and work schedules. Individual identification for each sampling frame member allows for responses to be monitored and follow-up contacts to be made to non-respondents. Establishing procedures for possible problems such as undeliverable email, returned incentives, and respondent questions will increase the number of usable returned surveys (Dillman et al., 2009, pp. 236-271).

Internet surveys are increasing combined with e-mail notifications. Survey response rates are increased by using some considerations unique to the Internet such as instructions on how to access the web survey, timing of emails to the recipients, and ensuring emails are not marked as spam (Dillman et al., 2009, pp. 271-296). Adding a postal mail component, such as a postal introductory letter, to the Internet survey, yields response rates from 50% to 59% (Dillman et al., 2009, p. 282). The subject line also influences response rates, with subject line of "'Please help…[name of company] with your advise and opinions'" having a 5% increase in response rates than a subject line "'Share your advise and opinions now with [name of company]'" (Dillman et al, 2009, p. 286).

Recruitment Procedures

The target sampling frame for the current research was composed of the North Carolina Community College educational administrators responsible for credit and noncredit educational programs impacted by PV applications. An Internet-based survey design was selected as the survey method expected to have the greatest response rate for the sampling frame. Educational administrators within the NCCCS were assumed to be computer and Internet competent as these tools have been in use since the 1980s.

A prenotice e-mail on Haywood Community College letterhead was sent from Dr. Rose Johnson (Haywood Community College) and Dr. Rusty Stephens (Wilson Community College), the NCCCS Code Green chairs. The prenotice e-mail from the two college presidents was intended to emphasize the connection between the survey and the value of the response to the Code Green objectives. The prenotice e-mail also included information about the email notification the administrators would receive from the researcher to complete the Internet survey. An email was sent from the researcher emphasizing the connection to the NCCCS Code Green CIP and importance of responding to the survey. A financial incentive was considered as a way to increase the response, but it was determined the value of a financial incentive was perceived not to be significant as compared to the actual value of the administrators' time on the survey (Trussell & Lavrakas, 2004, p. 351). Instead an incentive of receiving a copy of the final results of the study was offered. A follow-up email was sent a week after the email request to those who had not completed the survey with another request to complete the survey. A thank-you e-mail was sent two weeks after the initial email request to those who had completed the survey. A final email was sent with a new subject line including, "Please help…" to those who had not completed the survey. The prenotification e-mail and researcher email with the survey instructions were sent in March, approximately one and one-half months before the end of the semester, for the respondents to have adequate time to consider the surveys. E-mails were sent after business hours so that they would be received in the recipients' inboxes early in the morning. E-mails were designed and screened to minimize the message being flagged as spam. The e-mails are included in Appendix A.

Survey Implementation

An Internet survey program, Qualtrics, was used to host the survey and monitor progress. The e-mails were sent from the Qualtrics emailer. To increase the response rate, the researcher pre-notified the target population about the objectives and importance of the survey and the Code Green presidents sponsored the research. Procedures were established for identifying and analyzing returned e-mails. If the email was not deliverable, the address was checked for accuracy. If the initial address was incorrect, the address was corrected and the email was sent to the corrected address. The researcher answered questions from the recipients by phone and email and corrected any problems that arose. In two cases the recipient called or emailed to say they had passed the survey on to a different administrator more informed about the topic. Logs were monitored to analyze any electronic transmission errors.

Data Analysis

A statistical software package, SPSS, was used to analyze the results. In cases where the data files were not formatted correctly for SPSS analysis, the data were downloaded into Excel files for manual comparisons and analysis.

Awareness was measured by three survey questions on when the administrator first heard about PV skills training, level of familiarity with PV skills training organization, and familiarity with PV skills training certifications and accreditations. A respondent was considered aware with any response to the question "Approximately when did you first heard about PV skill training?" other than "This is the first I have heard of it."

Adoption was defined as an educational course with PV skills training as the primary subject or as a skill added to an existing course. Courses with PV skills training were identified from the archival data on the enrollment documented in the NCCCS Data Warehouse on the credit courses ALT 220 and ALT 221, and the noncredit course EGY 3002. Adoption was also measured by responses to survey questions on offering courses with PV skills as the primary subject and adding PV skills into existing credit and noncredit course courses. Credit and noncredit courses where PV skills was the primary subject, and were listed in the North Carolina Community College Data Warehouse were measured by identifying the semester and year a credit or noncredit NCCCS course received full time equivalency (FTE) recorded by the North Carolina Community College Data Warehouse. Noncredit courses when PV skills training was the primary subject, but a unique number was assigned by an individual college, were measured by a survey question asking if a course has been offered where PV skills was the primary subject. An additional question asked the respondent to list the name of the course if known. Adoption was also measured by the survey questions on addition of PV skills into existing credit or noncredit courses. For courses where PV skills were added, credit respondents were asked in what subject area the PV skills were added and noncredit respondents were asked to list the name of the course if known.

Archival and survey data were analyzed to answer the research questions. Descriptive statistics were provided for each research question and some demographic variables were incorporated into inferential analysis (Table 3). Research questions were analyzed based on all respondents and the within-college comparisons were based on matched pairs from the community colleges in which both the credit and noncredit administrator responded. Administrator "background" was defined by a subset of variables from the demographic sections that were related to their awareness. Credit enrollment was defined as the total unduplicated head count of all programs for the 2010-11 academic year. Noncredit enrollment was defined as the sum of the unduplicated head count of the regular and self-supporting occupational programs.

Table 3

Data Analysis for Research Questions

Research Question (RQ)	Data Source[a]	Analysis Method
RQ1 - How widespread is credit and noncredit community college administrators' awareness of PV skills training for occupations impacted by photovoltaics?	CR & NC – SQ8 When did you first hear about PV skills training.	Percentage not aware and percentage aware by when first heard for credit and noncredit administrators.
	CR & NC – SQ9 Familiar with PV skills training programs offered by different organizations.	Frequency and percentage aware of PV skills training programs by organization.
	CR & NC – SQ10 Familiar with PV skills training accreditations.	Frequency and percentage aware of PV skills training accreditations.
	CR & NC – SQ 11 Familiar with PV skills training certifications.	Frequency and percentage aware of PV skills training certifications.
RQ1A Is there a relationship between awareness and administrator background?	CR & NC – SQ8 When did you first hear about PV skills training.	Comparison of the frequency and percentage aware and not aware within subgroups based on years worked other than current community college and highest earned academic degree.
	CR & NC – SQ6 Years worked somewhere other than this community college.	
	CR&NC – SQ7 Highest earned academic degree.	
RQ1B Is there a relationship between the number of years since administrators in the same college learned about PV skills training?	CR & NC SQ8 – When did you first hear about PV skills training.	Frequency distribution and mean difference in years ago learned by pairs, calculated as credit minus noncredit.
RQ1C Is there a relationship between administrator awareness	CR & NC SQ8 – When did you first heard of PV skills training.	Crosstabulation of enrollment and years since first heard of PV skills

and college enrollment.	NCCCS enrollment data 2010-11.	training. Spearman rho test for relationship between years ago heard and enrollment.
RQ2 - How do credit and noncredit administrators become aware of PV skills training?	CR & NC SQ12 and SQ 13 – Where heard and from whom heard about PV skills training.	Frequency and percentage where learned for CR and for NC.
RQ2A Is there a relationship between how administrators in the same college became aware?	CR & NC SQ12 and SQ 13 – Where heard and from whom heard about PV skills training.	Frequency and percentage of pairs who learned from common source and not from common source.
RQ2B - Is there a relationship between how administrators became aware and college enrollment?	CR & NC SQ12 and SQ 13 – Where heard and from whom heard about PV skills training. NCCCS enrollment data 2010-11.	Crosstabulation of methods of awareness for categories of enrollment for CR and NC. Spearman rho test for relationship between sources of awareness and enrollment.
RQ 3 How widespread is adoption of PV skills training into credit and noncredit community college programs?	Archival NCCCS data. NC SQ14 taught PV primary course, SQ16 added PV concepts	CR & NC frequency of PV skills adoption for PV primary and PV added skill courses. Frequency of awareness of PV skills training, PV added skills courses and PV primary skills courses.
	CR - SQ 14 taught PV skills training in other courses, SQ 15 academic areas and degree levels PV taught in.	CR - Frequency and percentage of PV primary or added skills by program area and degree level.
	NC - SQ15 name of course, with PV primary skill, SQ17 name of course with PV skills added.	NC - List of course names for PV primary added skills courses.

	CR SQ 17, NC SQ 18 how likely to offer PV primary or PV added in the future.	Frequency and percentage of likeliness of future offering of PV skills training as primary or add-on.
RQ3A Is there a relationship between adoption and college enrollment?	NCCCS enrollment data 2010-11. CR - SQ 14 taught PV skills training in other courses, SQ 15 academic areas PV taught in. NC - SQ14 taught PV primary course, SQ16 added PV concepts	Independent-samples Mann-Whitney U test for differences between adoption of PV primary versus added skills and enrollment.
RQ4 What sources of information do credit and noncredit administrators cite as important in their decision to adopt PV skills training?	CR – SQ18, NC – SQ 19 how important are factors for adding PV primary or add-on skill training.	CR & NC – Frequency and percentage of importance for each factor.
RQ4A Is there a relationship between information cited as important for adoption by credit and noncredit administrators at the same college?	CR – SQ18, NC – SQ19 how important are factors for adding PV primary or add-on skill training.	Frequency and percentage of agreement between college paired administrators.
RQ4B Is there a relationship between information cited as important for adoption college enrollment?	NCCCS enrollment data 2010-11. CR – SQ18, NC – SQ19 how important are factors for adding PV primary or add-on skill training.	Scatter plots of enrollment and information cited as important for adoption.

Note. [a]CR=credit administrators, NC=noncredit administrators, SQ=survey question.

CHAPTER 4: RESULTS

The purpose of the current research is to understand the factors related to PV educational programming decisions, including awareness of the need for and the adoption of PV skills training into the technical educational programming of the community colleges. The following research questions were explored in this study:

1. How widespread is credit and noncredit community college administrators' awareness of PV skills training for occupations impacted by PV?

    a. Is there a relationship between awareness and administrator background?

    b. Is there a relationship between the number of years since administrators in the same college learned about PV skills training?

    c. Is there a relationship between administrator awareness and college enrollment?

2. How do credit and noncredit community college administrators become aware of PV skills training?

    a. Is there a relationship between how administrators in the same college became aware?

    b. Is there a relationship between how administrators became aware and college enrollment?

3. How widespread is adoption of PV skills training into credit and noncredit community college programs?

    a. Is there a relationship between adoption and college enrollment?

4. What sources of information do credit and noncredit administrators cite as important in their decision to adopt PV skills training?

a. Is there a relationship between information cited as important for adoption by credit and noncredit administrators at the same college?

b. Is there a relationship between information cited as important for adoption and college enrollment?

Quantitative data were collected from the NCCCS Data Warehouse and two surveys of community college administrators. One survey was from a sample of the credit administrators responsible for the curriculum programs for technical education in the 58 North Carolina community colleges. A second survey was from a sample of the noncredit administrators responsible for continuing education in the 58 North Carolina community colleges. After describing the respondents, this chapter reviews the responses to the two surveys and the data from the Data Warehouse to answer the research questions. Results are organized into sections by research questions.

Description of the Respondents

There were 41 responses to the credit survey (71% response rate) and 30 responses to the noncredit survey (52% response rate). Fifty-one (88%) of the 58 NCCCS colleges were represented in the survey. There were 21 colleges (36%) with respondents to both the credit and noncredit surveys. The respondents' job titles are summarized in Table 4.

Table 4

Titles of Credit and Noncredit Respondents

Title	Credit ($N = 41$)		Noncredit ($N = 30$)	
	N	%	*n*	%
Dean or Associate Dean	24	59	14	48
Vice President	9	22	10	32
Department or Division Chair	5	12	0	0
Director	1	2	6	19
Other	2	5	0	0

The respondents to both surveys were most frequently deans or associate deans. The respondents to the credit and noncredit surveys reported a similar distribution of titles with the exception of department chair and director. Department or division chair are typical titles for first level curriculum credit administrators, and director is a more typical title for first level noncredit administrators. Two credit administrators selected the title category "other"; one administrator title was "Lead Instructor" and the second administrator did not specify a title.

The programs supervised by the credit respondents are shown in Table 5. The frequency and percentage of credit respondents is compared to the frequency and percentage of the programs offered at all North Carolina community colleges.

Table 5

Program Areas Supervised by Credit Respondents and North Carolina Community Colleges Offering the Programs

Program	Credit Respondents ($N = 41$)		NCCCS Programs ($N = 58$)	
	n	%	*n*	%
Electrical/Electronics Technology (35220)	29	71	43	74
Electronics Engineering Technology (40200)	23	56	37	64
Industrial System Technology (50240)	21	51	39	67
Building Construction Technology (35140)	9	22	11	19
Sustainability Technologies (40370)	9	22	16	28
Construction Management (35190)	6	15	6	10
Electrical Engineering Technology (40180)	5	12	5	9
Other	23	56		

Note. Source for NCCCS Programs: North Carolina Community College System. (2012d). *Education catalog.* Retrieved from http://www.nccommunitycolleges.edu/Programs/education_catalog.htm

Electrical/Electronics Technology, Electronics Engineering Technology, and Industrial Systems Technology are offered at more colleges than any of the other program areas and had the highest number of survey responses. The three programs with the greatest representation in the survey responses were electrical/electronics technology (71%), electronics engineering technology (56%), and industrial systems technology (51%). Each area was slightly underrepresented as compared to the NCCCS percentages. Overall the percentage of credit respondents for each program was consistent with the relative number of the programs offered at the 58 North Carolina community colleges. The other program areas represented a wide range of programs not related to occupations impacted by PV skills training including areas such as Automotive Services and Horticulture.

The programs supervised by the noncredit respondents are shown in Table 6. There is no point of comparison for the noncredit program areas available in the NCCCS.

Table 6

Program Areas Supervised by Noncredit Respondents (N = 30)

Program	*n*	%
Continuing Education	28	93
Workforce Development	21	70
Economic Development	10	33
Customized Training	18	60

The noncredit program areas are defined by the objective of the program for specific categories of students rather than by technical program as in the credit areas. Continuing education is a broad category that may or may not include workforce development, customized training, and economic development. Nearly all respondents (93%) reported supervising the continuing education area and one of the other three areas.

Credit administrators on average have been employed longer at other locations than at their current college. Credit respondent employment history at their current college and at all other employment locations is shown in Table 7.

Table 7

Credit Respondents' Years Employed at Current and Other Than Current College

Years	Current College (N = 41)		Other Than Current College (N = 35)	
	n	%	*n*	%
0-5	11	27	2	6
6-10	5	12	11	31
11-15	8	20	4	11
16-20	5	12	5	14
>20	12	29	13	37

Noncredit administrators on average have been employed longer at other locations than at their current college. Noncredit respondent employment history at their current college and at all other employment locations is shown in Table 8.

Table 8

Noncredit Respondents' Years Employed at Current and Other Than Current College

	Current College (N = 30)		Other Than Current College (N = 25)	
Years	*n*	%	*n*	%
0-5	11	37	1	4
6-10	4	13	5	20
11-15	9	30	7	28
16-20	2	7	4	17
>20	4	13	8	32

The majority of noncredit respondents (84%) reported have been employed at organizations other than their current college inside and outside of the NCCCS. The other employment areas for credit and noncredit respondents are shown in Table 9.

Table 9

Employment Other Than Current College

	Credit (N = 35)		Noncredit (N = 26)	
Employment Location	*n*	%	*n*	%
NC community college	15	43	8	31
Manufacturing	13	37	1	4
Community college other state	10	29	1	4
Educational institution other state	5	14	1	4
Other NC educational institution	3	9	2	8
Other	13	37	13	50

Eighty percent (n = 33) of credit respondents reported having worked in some type of higher education in or out of North Carolina, and 37% (n = 13) reported having worked in manufacturing. Thirty-nine percent (n = 12) of the noncredit administrators reported having worked in some type of higher education in or out of North Carolina, and 50% (n = 13) reported working in a wide range of other areas including health care and the military.

The highest earned academic degree of the respondents is shown in Table 10.

Table 10

Respondents' Highest Earned Academic Degree

	Credit (N = 41)		Noncredit (N = 30)	
Degree	n	%	n	%
Doctorate	12	29	4	13
Master's	23	56	23	74
Bachelor's	2	5	2	5
Associate's	1	2	0	0
Other	3	7	2	6

The most frequent highest earned degree was a master's degree (credit = 56%, noncredit = 74%) followed by a doctoral degree (credit = 29%, noncredit = 13%).

Research Question One: Awareness of PV Skills Training

The first research question focuses on awareness of PV skills training for occupations impacted by PV. Subquestions include:

A. Is there a relationship between awareness and administrator background?

B. Is there a relationship between the number of years since administrators in the same college learned about PV skills training?

C. Is there a relationship between administrator awareness and college enrollment?

How Widespread Is Awareness?

Awareness was defined by administrators' responses to a questions regarding length of time since they first heard of PV skills training. Respondents were considered unaware if they answered, "This is the first I have heard of it." Ninety-five percent of credit administrators and 90% of noncredit administrators were generally aware of PV skills training. Respondents have been aware of PV skills training ranging from over five years to less than one year as shown in Table 11.

Table 11

How Many Years Since First Heard About PV Skills Training

# of years	Credit (N = 41)		Noncredit (N = 30)	
	n	%	*n*	%
0	2	5	3	10
<1	4	10	5	17
1 to <2	6	15	6	20
2 to <3	9	22	3	10
3 to <4	3	7	6	20
4 to <5	7	17	1	3
>5	10	24	5	17
do not recall			1	3

Twenty-four percent of credit administrators and 17% of noncredit administrators learned about PV skills training over five years ago. Forty-eight percent of credit administrators and 43% of noncredit administrators learned about PV skills training three or more years ago. Ten percent of credit administrators and 17% of noncredit administrators were new to the idea of PV skills training (aware less than one year).

Administrators were further asked about their general familiarity with PV skills training, and their familiarity with specific organizations offering PV skills training, PV skills training certifications, and PV skills training accreditations. The frequency of awareness for these four areas is shown in Table 12 for the credit and the noncredit respondents.

Table 12

Awareness of PV Skills Training Type Required for Occupations Impacted by PV

Training Type	Credit ($N = 41$)		Noncredit ($N = 30$)	
	n	%	*n*	%
PV Skills Training (general knowledge)	39	95	27	90
PV Skills Training Organizations				
CE[a] at a community college	26	63	17	57
CU[b] at a community college	23	56	10	33
CE[a] at a four year college or university	13	32	11	37
Private trainer	11	27	6	20
CU[b] at a four year college or university	9	22	3	10
PV standards organization	8	20	7	23
PV equipment manufacturer or distributor	8	20	5	17
NJATC[c]	7	17		
Underwriters Laboratory	4	10	1	3
Electric Utility Company	2	5	5	17
PV Skills Training Certifications				
NABCEP[d] PV Installer or Technical Sales	14	34	7	23
Do not know specific certifications	9	22	4	13
NABCEP but not specific certifications	4	10	4	13
IREC/ISPQ[e] for Independent or Affiliated Master Trainers, Affiliated or Independent Instructors	4	10	2	7
IREC/ISPQ but not specific certifications	4	10	3	10

PV Skills Training Accreditations				
IREC/ISPQ for Training Programs	3	12	4	13
IREC/ISPQ for Continuing Education Programs	2	5	4	13

Note. [a] = Continuing Education, [b] = Curriculum, [c] = National Joint Apprenticeship and Training Committee, [d]=North American Board of Certified Energy Practioners, [e]Interstate Renewable Energy Council/Institute for Sustainable Power.

The highest rates of awareness were general knowledge of PV skills training (credit 95%, noncredit 90%). Respondents were less familiar with specific PV skills training organizations. Administrators were the most familiar with PV skills training by continuing education at a community college (credit = 63%, noncredit = 57%), followed by curriculum programs at a community college (credit = 56%, noncredit = 33%) and continuing education at a four-year college or university (credit = 32%, noncredit = 37%). Administrators were less familiar with PV skills training certifications. The most recognized PV skills certification was the NABCEP PV Installer or Technical Sales (credit = 34%, noncredit = 23%). Very few administrators were aware of PV skills accreditations. The IREC/ISPQ accreditation for training programs was recognized by 12% of credit and 13% of noncredit administrators.

Is There a Relationship Between Awareness and Administrator Background?

The relationship between administrator background variables including past employment and highest earned degree and administrator general awareness of PV skills training was examined. The credit and noncredit administrators were considered together because of their similar backgrounds and rates of awareness. Over 90% of all educational administrators had general knowledge of PV skills training if they had or had not worked at other than their current community college as shown in Table 13. Ninety-six percent of respondents with a master's degree had general awareness of PV skills training as compared to 88% of administrators with doctoral degrees.

Table 13

PV Skills Training General Awareness and Administrator Background

	Not Aware		Aware	
Administrator Background	*n*	%	*n*	%
Worked Other Than Current Community College				
Yes	4	7	56	93
No	1	9	10	91
Highest Earned Degree				
Doctorate	2	12	14	88
Master's	2	4	44	96
Bachelor's			3	100
Associate's			1	100

Overall, PV skills general awareness was extremely high and there were no observable differences based on background variables.

Is There a Relationship Between the Number of Years Ago Administrators at the Same College Became Aware of PV Skills Training?

Seventeen of the original 21 pairs of credit and noncredit administrators were examined for a relationship between the number of years ago administrators at the same college became aware of PV skills training. Four of the original pairs were eliminated from the analysis because one of the administrators in the pair was unaware of PV skills training. The difference of when the administrators first learned of PV skills training in the same college is shown in Table 14. The largest number in the years ago awareness range was used for the calculation. For example if the response was “2 to < 3 years ago” a value of 3 years was assigned to the respondent. The response “>5 years” was given a value of 6. The difference was calculated as the credit years aware minus the noncredit years aware.

Table 14

Difference Between When Administrators in Same College First Learned About PV Skills Training (N = 17)

Difference in Years (credit – noncredit)	*n*	%
4	2	12
3	2	12
2	4	24
1	1	6
0	1	6
-1	1	6
-2	1	6
-3	2	12
-4	2	12
-5	1	6

Administrators at the same college did not learn about PV skills training at the same time. In 54% of the pairs the credit administrator learned of PV skills training before the noncredit administrator. Forty-two percent of the noncredit administrators learned about PV skills training before the credit administrators. In one college, the credit and noncredit administrators learned about PV skills training at the same time, over five years earlier. The average difference between time since credit and noncredit administrators learned about PV skills training was 0.06 years (*SD* = 3.03). There was no consistent pattern of the difference between credit and noncredit administrators at the same college. There was a similar variation of the time distribution of credit administrators learning first and noncredit administrators learning first.

Is There a Relationship Between Administrator Awareness and College Enrollment

Credit and noncredit college enrollment records from the North Carolina Community College website for the year 2010-2011 were evaluated (North Carolina Community College System, 2012a). The enrollment total for associate, diploma, certificate, and transfer was used for the curriculum enrollment. The regular budget and self-supporting occupational categories of continuing education were selected for comparison. The relationship between enrollment and time since credit administrators became aware of PV skills training is shown in Table 15. The 2010-11 curriculum enrollment ranged from 990 to 29,738 (*M* = 6,816, *SD* = 6,167).

Table 15

Relationship Between Time Since Awareness and College Enrollment Credit Administrators (N = 41)

		Years since awareness													
		0		<1		1 to <2		2 to <3		3 to <4		4 to <5		>5	
Enrollment	*N*	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
0-2999	10	1	10	3	30	3	30	1	10					2	20
3000-5999	16	1	6	1	6	1	6	3	19	1	6	6	37	3	19
6000-8999	7					2	28	3	43					2	28
>9000	8							2	25	2	25	1	12	3	38

Note. The actual enrollment for each college was used in the spearman rho analysis. The enrollment is grouped in the figure for ease of presentation.

A spearman rho test was performed for the relationship between years since credit administrators first learned of PV skills training and curriculum enrollment. There was a moderate positive correlation between years since credit administrators learned about PV skills training and the credit enrollment (r_s = .384, p = .013).

The enrollment and years ago noncredit administrators first learned of PV skills training is shown in Table 16. One noncredit administrator responded “do not recall” and was not included in the data. The 2010-11 combined regular budget and self-supporting budget occupational enrollment ranged from 593 to 22,990 (*M* = 4,895, *SD* = 4,312).

Table 16

Relationship Between Time Since Awareness and College Enrollment Noncredit Administrators (N = 29)

		Years since awareness													
		0		<1		1 to <2		2 to <3		3 to <4		4 to <5		>5	
Enrollment	*N*	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
0-2999	11	2	18	2	18	3	27	1	9	1	9	1	9	1	9
3000-5999	11	1	9	2	18			1	9	4	36			2	18
>6000	8			1	12	3	37	1	12	1	12			2	25

Note. The actual enrollment for each college was used in the analysis. The enrollment is grouped in the figure for ease of presentation.

A spearman rho test was performed for the relationship between years ago noncredit administrators first heard of PV skills training and noncredit enrollment. There was not a statistically significant correlation between years ago noncredit administrators learned about PV skills training and the noncredit enrollment ($r_s = .116$, $p = .542$).

Research Question Two: Sources of Awareness

The second research question focuses on how credit and noncredit administrators become aware of PV skills training. Subquestions include:

A. Is there a relationship between how administrators in the same college become aware?

B. Is there a relationship between how administrators become aware and college enrollment?

How Do Credit and Noncredit Administrators Become Aware of PV Skills Training?

The educational administrators were asked how they became aware of PV skills training. One survey question asked about impersonal sources where administrators learned about PV skills training and another survey question asked about interpersonal sources from whom administrators learned about PV skills training. The sources of administrators' knowledge of PV skills training is shown in Table 17. The current research question is based only on those who were aware of PV skills training.

Table 17

How and From Where Administrators Learned About PV Skills Training

	Credit (N = 39)		Noncredit (N = 28)	
Learned From	*n*	%	*n*	%
Impersonal Sources				
News report	22	56	12	43
NCCCS Code Green	21	54	14	50
NCCCS CIP[a]	21	54	8	29
Article or book	15	38	6	21
Business advertising	13	33	5	18
PV on our campus	11	28	8	29
NC energy report	10	26	6	21
Professional society	6	15	5	18
NC legislation	3	8	2	7
Interpersonal Interactions				
CU[b] instructor at my college	19	49	5	18
Distributor or sales person	11	28	5	18
CE[c] instructor at my college	10	26	8	29
Business/community leader	7	18	5	18
Speaker at meeting	7	18	9	32
CU[b] instructor another college	7	18	2	7
My supervisor/college administrator	4	10	7	25
CE[c] instructor another college	4	10	4	14
Students at my college	2	5	0	0
Friends/family	2	5	1	4
Administrator another college	2	5	2	7
Do not recall	2	5	1	4
Other	6	15	3	11

Note. [a]CIP = Curriculum Improvement Project; [b]CU = Curriculum; [c]CE = Continuing Education.

More than half of credit administrators reported becoming aware of PV skills training from news reports (56%), NCCCS Code Green (54%), or the NCCCS CIP

(54%). Other frequent sources of awareness mentioned by credit administrators were curriculum instructors (49%), articles or books (38%), and business advertising (33%). Other sources of learning by credit administrators were business partners, Duke Energy CEO, own research and the North Carolina Solar Center.

The NCCCS Code Green (50%) and news reports (43%) were the two most frequent places noncredit administrators learned about PV skills training, but at lower rate than credit administrators. The third most frequent source was speakers at a professional meeting (32%). The fourth most frequent sources were the NCCCS Curriculum Improvement Project (29%), PV on their campus (29%) and from continuing education instructors (29%). In addition to the choices provided on the survey, noncredit administrators mentioned the Advanced Technology Environmental and Energy Center (Advanced Technology Environmental and Energy Center, n.d.), the North Carolina Solar Center, and the Workforce Development Board as sources of awareness.

Is There a Relationship Between How Administrators in the Same College Become Aware?

This research question investigates if there is a relationship between how administrators working at the same college learned about PV skills training. There were 17 pairs of credit and noncredit administrators aware of PV skills training from the same college answering the surveys. There were 9 pairs (53%) where there were no common methods of learning about PV skills training. There were 8 (47%) pairs where the two administrators both reported learning about PV skills training in some of the same ways. Table 18 lists the sources that were common and were not common for the paired administrators.

Table 18

Sources of Learning About PV Skills Training by Credit and Noncredit Administrators at Same College (N = 17)

Source	Common *n*	Common %	Not Common *n*	Not Common %
Impersonal				
Code Green	5	29	12	70
Super CIP	4	24	13	76
News report	3	18	14	82
PV array on our campus	2	12	15	88
Article/book	1	6	16	94
Business advertising	1	6	16	94
Interpersonal				
CU instructor at my college	2	12	15	88
My supervisor/college administrator	2	12	15	88
CE instructor at my college	1	6	16	94
Administrator another college	1	6	16	94
Speaker at a meeting	1	6	16	94
Business/community leader	1	6	16	94
NC energy report			17	100

Note. CIP = Curriculum Improvement Project; CU = Curriculum; CE = Continuing Education.

Administrators had more differences than commonalities in how they became aware of PV skills training. The most frequent common learning source was from the Code Green project (29%) and the Super CIP (24%). The Code Green was a NCCCS internal program and the most frequent overall source for noncredit and the second most frequent source for credit administrator awareness when considered individually. There is a very limited relationship between how administrators in the same college become aware.

Is There a Relationship Between How Administrators Become Aware and College Enrollment?

The NCCCS colleges' credit enrollment of colleges responding to the survey differed by a factor of 30, from very small colleges with credit enrollments of 990 to very large colleges with credit enrollments of 29,738. Noncredit occupational enrollment of colleges responding to the survey differed by a factor of more than 38 times from 593 to 22,990. The current research investigated if the difference in enrollment was related to how administrators became aware of PV skills training. Table 19 reports the different sources credit administrators learned about PV skills training by enrollment category.

Table 19

How Credit Administrators Learned About PV Skills Training Areas by College Enrollment

	Enrollment 2010 - 2011							
	0-2,999 (*N* = 10)		3,000-5,999 (*N* = 16)		6,000-8,999 (*N* = 7)		>9,000 (*N* = 8)	
Learned From	*n*	%	*n*	%	*n*	%	n	%
Impersonal								
News report	3	14	9	41	4	18	6	27
NCCCS CIP	2	10	9	43	5	24	5	24
NCCCS Code Green	2	12	6	35	4	24	5	29
Article or book	1	7	6	40	3	20	5	33
Business advertising	1	8	6	46	2	15	4	31
PV on our campus	1	9	5	45	2	18	3	27
NC energy report			5	50	1	10	4	40
Prof society publication	2	33	1	17	1	17	2	33
NC legislation			1	33	1	33	1	33
Interpersonal								
CU Instructor my college	2	11	9	47	4	21	4	21
PV sales person	1	9	3	27	2	18	5	45
CE instructor my college	1	10	4	40	2	20	3	30
Speaker at meeting	1	14	3	43			3	43
Business/community leader			2	29	1	14	4	57
CU instructor other college			2	29	3	43	2	29
Supervisor or administrator my college	1	25					3	75
CE instructor other college	1	25	1	25	1	25	1	25
Friends/family			1	50			1	50
Administrator another college			1	50			1	50
Students at college							2	100

Note. The actual enrollment for each college was used in the spearman rho analysis. The enrollment is grouped in the figure for ease of presentation.

All enrollment categories identified news reports, CIP and Code Green as three of their most frequent sources of learning about PV skills training. Enrollment played a role in the overall number of sources administrators identified as methods of becoming aware. A spearman rho test was performed for the relationship between the total number of sources of learning cited and credit enrollment. There was a moderate positive correlation between total number of sources of learning and curriculum enrollment ($r_s = .385$, $p = .015$).

Noncredit administrator source of awareness and noncredit enrollment were investigated. Code Green and new reports were cited the most frequently in all enrollment categories as shown in Table 20.

Table 20

How Noncredit Administrators Learned About PV Skills Training by College Enrollment

	Enrollment					
	0-2,999 (N = 11)		3,000-5,999 (N = 11)		>6,000 (N = 8)	
Learned From	n	%	n	%	n	%
Impersonal						
NCCCS Code Green	4	29	6	43	4	29
News report	4	36	4	36	3	27
NCCCS CIP	2	25	4	50	2	25
PV on our campus	2	29	4	57	1	14
Article or book	3	60	1	20	1	20
NC energy report	2	40	1	20	2	40
Prof society publication	2	50	1	25	1	25
Business advertising	1	25	1	25	2	50
NC legislation					1	10
Interpersonal						
CE instructor my college	3	38	3	38	2	25
Speaker at meeting	3	38	2	25	3	38
Supervisor or administrator my college	3	43	1	14	3	43
CU Instructor my college	1	20	1	20	3	60
Business/community leader	1	20	2	40	2	40
PV sales person	1	25	1	25	2	50
CE instructor other college	2	67	1	33		
Friends/family			2	67	1	33
CU instructor other college	1	50	1	50		
Administrator another college	1	50			1	50

Note. The actual enrollment for each college was used in the spearman rho analysis. The enrollment is grouped in the figure for ease of presentation.

A spearman rho test was performed for the relationship between number of sources of learning about PV skills training and noncredit enrollment. There was not statistically significant correlation between the total number of sources of learning and noncredit enrollment (r_s = -.117, p = .561).

Colleges of all enrollments sizes frequently learned about PV skills training from Code Green, CIP, and news reports. There was a moderate positive correlation between the total number of learning sources cited and enrollment for credit administrators but not for noncredit respondents.

Research Question Three: Adoption of PV Skills Training

The focus of the research question is to understand how widespread the adoption of PV skills training is across the 58 community colleges and if there is a relationship between adoption and enrollment.

Adoption was defined as offering a course with PV skills training as the primary objective or adding PV skills training into existing courses. Thirty-one (61%) of the 51 colleges responding to the survey reported adopting some type of PV skills training in credit or noncredit programs as a primary skills training or PV as an added skill into an existing course. Table 21 reports adoption frequencies for PV primary skills and added skills courses for the credit and noncredit program areas. Credit PV primary adoption is based on the NCCCS Data Warehouse records, and other adoption is based on survey results. The reported adoption rates were greatest for PV added skills courses in both the credit (36%) and noncredit (39%) areas and the PV primary in noncredit (35%). The lowest frequency was adoption of PV primary skills courses, ALT 220, in the curriculum credit area (21%).

Table 21

Adoption of PV Primary Skills Courses and PV Added Skills Courses

	PV Course Adoption	
	primary skill	added skill
Academic Area	%	%
Credit	21	36
Noncredit	35	39

Awareness occurs before adoption in the diffusion of innovation model. The adoption rate is less than half of the overall awareness rates for credit and noncredit administrators as shown in Figure 4.

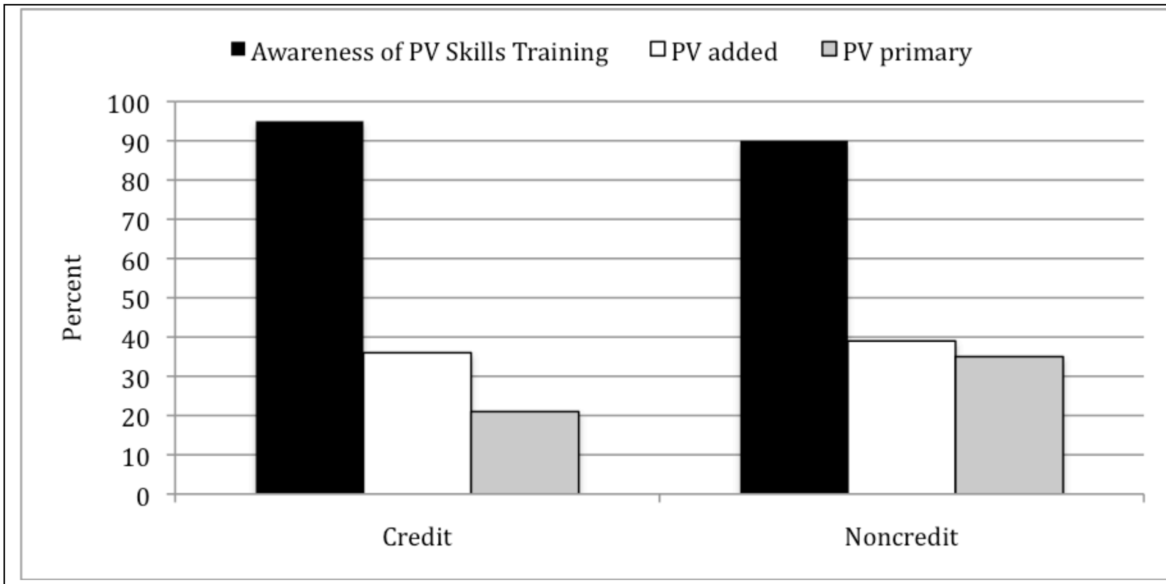

Figure 4. Awareness and adoption of PV skills training for primary and added skills courses.

PV skills training was adopted as either a primary course or added into different program areas and at different degree levels in the credit areas. Table 22 lists the distribution by academic area and degree level.

Table 22

PV Primary or Adopted Skills Training Added to Degrees

		Degree Level					
		Associate		Diploma		Certificate	
Academic Area	*N*	*n*	%	*n*	%	*n*	%
Electrical Engineering Technology (40180)	5	2	40			1	20
Sustainabilities Technologies (40370)	9	3	33	1	11	2	22
Electronics Engineering Technology (40200)	23	7	30				
Electrical/Electronics Technology (35220)	29	7	24	7	24	5	17
Construction Management (35190)	6	1	17				
Industrial Systems Technology (50240)	21	3	14	1	5	1	5
Building Construction Technology (35140)	9	1	11				

Note. Percentages for the degrees are calculated considering the number of program areas represented in the survey as shown in Table 6.

Credit administrators reported adding PV skills training into seven specific curriculum program areas at the associate, diploma, or certificate levels. Electrical program areas as a group had the greatest frequency of the addition of PV skills training. Electronics Engineering Technology and Electrical/Electronics Technologies had the greatest frequency for the addition of PV primary or added skill courses (n = 7). Electrical Engineering Technology had the greatest percentage (40%) for the addition of PV primary or added skill courses.

Seven colleges had offered the noncredit EGY 3002 course as of the fall 2011 semester. Ten administrators reported their colleges had added noncredit courses with the primary objective of providing PV skills training. Noncredit courses may have unique names as designated by an individual college. It was not clear from the data if the noncredit respondents reporting their college had offered a course with PV skills training as the primary topic were the same as the data warehouse record of the EGY 3002 course. Considering both the EGY 3002 and the survey response of having offered a PV primary noncredit course, 16 unique colleges are represented as having offered some PV in the noncredit area. The course names reported are listed in Table 23. Eleven colleges reported they had added PV concepts into existing continuing education courses. The courses where PV concepts were added are also listed in Table 23.

Table 23

Noncredit Courses With PV Skills Training

Primary	Added
Intro to Solar Electricity/Photovoltaics	Electrical Wiring Fundamentals
Introduction to PV Technology	Electrician's Assistant (JobsNOW)
Photovoltaics for the Electrician	Emerging Trends in High Perf. Building
Solar Electric Training	Green Building Construction Guidelines
Solar Installation	Green Building Construction Overview
Solar Photovoltaic Installer	HVAC Certificate Program (JobsNOW)
Solar PV Installation	Introduction to Renewable Energy
Solar Thermal Design and Installation	Photovoltaic
Weatherization and Home Energy Reduction	Renewable Energy Technology

All administrators were asked how likely is it that their college will offer (or continue to offer) courses where PV skills training is the primary topic or where PV skills training is a topic, assignment, or a section in a curriculum course (where PV skills training is not the primary topic) in the future. Fifty percent for more of the credit and noncredit administrators responded their colleges were very likely to offer or continue to offer PV skills training as a primary or add-on skill in future courses as shown in Table 24. For example, one credit respondent stated, "Beginning in Fall 2012 the college will incorporate photovoltaics in appropriate lesson plans in vocational/technical programs." Noncredit administrators were almost equally divided between very likely and somewhat likely to offer PV skills training in the future. The credit administrators not responding very likely were more divided about the future possibility of adding these skills. The six respondents indicating they were very unlikely to offer PV skills training all represented colleges reporting no adoption of PV skills training in credit or noncredit areas.

Table 24

Likeliness of Future Offering of PV Skills Training as a Primary or Add-On

Likeliness	Credit (*N* = 41) *n*	Credit (*N* = 41) %	Noncredit (*N* = 30) *n*	Noncredit (*N* = 30) %
Very likely	23	56	15	50
Somewhat likely	10	24	14	47
Very unlikely	5	12	1	3
Undecided	3	7		

Is There a Relationship Between Adoption and College Enrollment?

Adoption of PV skills as a primary or added skill is considered with college enrollment. Enrollment is easily measured but may be related to other factors such as resources available. Table 25 examines PV skills and curriculum enrollment.

Table 25

Percent of Colleges Adding PV as a Primary or as an Added Topic

	Enrollment							
	0-2,999 (*N* = 9)		3,000-5,999 (*N* = 17)		6,000-8,999 (*N* = 7)		> 9,000 (*N* = 8)	
Credit	*n*	%	*n*	%	*n*	%	*n*	%
Primary	1	11	3	33	3	33	2	25
Added	2	15	4	31	3	23	4	50

Note. The actual enrollment for each college was used in the Mann-Whitney analysis. The enrollment is grouped in the figure for ease of presentation.

A Mann-Whitney test was performed on the distribution of enrollment and adoption of PV primary and added skill courses. The enrollment for colleges adopting credit PV primary courses is slightly larger than those that chose not to adopt ($U = 333$, $p = .014$).

The distribution of enrollment for colleges adopting credit PV added skills courses is the same as those that chose not to added PV skills (*U* = 239, *p* = .113).

Noncredit areas were also evaluated for the relationship between adoption of PV skills as primary or as an added skill, with enrollment. Table 26 displays the results for adoption of PV skills as primary or added for enrollment categories.

Table 26

Percent of Colleges Adding PV as a Primary or as an Added Topic

	Enrollment					
	0-2,999 (*N* = 11)		3,000-5,999 (*N* = 11)		>6,000 (*N* = 8)	
Noncredit	*n*	%	*n*	%	*n*	%
Primary	1	10	5	50	4	40
Added	3	27	4	36	4	36

Note. The actual enrollment for each college was used in the Mann-Whitney analysis. The enrollment is grouped in the figure for ease of presentation.

A Mann-Whitney test was performed on the distribution of enrollment and adoption of PV primary and added skill courses. The enrollment for colleges adopting credit PV primary courses is greater than for those that chose not to adopt (*U* = 164, *p* = .009). The distribution of enrollment for colleges adopting credit PV added skills courses is the same as those that chose not to added PV skills (*U* = 140, *p* = .133).

Research Question Four: Influences on Adoption Decisions

The focus of the current research question is on what information credit and noncredit administrators cite as important in their decision to adopt PV educational programming. Subquestions include:

A. Is there a difference between information cited as important for adoption by credit and noncredit administrators in the same college?

B. Is there a relationship between information cited as important for adoption and college enrollment?

What Sources of Information Do Credit and Noncredit Administrators Cite as Important in Their Decision to Adopt PV Skills Training?

Administrators become aware of an innovation, process the new ideas and then make a decision to adopt or reject the innovation. The information important to the administrator for making an adoption decision can be internal issues such as faculty issues and resource availability, to external factors such as business requests and advisory boards. Availability of qualified faculty, faculty technical skills, and funding for equipment were the most-cited areas by credit and noncredit respondents as very important in their decision to adopt PV educational programming. Table 27 displays the areas credit administrators identified as important to their adoption decisions.

Table 27

Importance of Factors in the Credit Administrator Adoption Decision (N = 41)

Factor	very important *n*	very important %	somewhat important *n*	somewhat important %	not important *n*	not important %
Faculty adjunct technical skills	32	78	4	10		
Availability of qualified faculty/adjunct	32	78	3	7	1	2
Funding for equipment	31	76	5	12		
Skills lead to student employment	30	73	5	12		
Faculty/adjunct willingness to develop course	29	71	5	12	2	5
Faculty/adjunct willingness to teach courses	29	71	6	15	2	5
Area business requested	25	61	9	22	2	5
Advisory board suggested	23	56	12	29	1	2
Expect students to enroll	22	54	12	29	2	5
Personal philosophy important to students	12	29	18	44	6	15
Personal philosophy of college responsibility	12	29	23	56	2	5
External funding available	12	29	20	49	4	10
Will become a requirement in NCCCS	11	27	16	39	9	22
Administrator suggested or required	9	22	23	56	4	10
Technology is exciting	8	20	16	39	12	29
Want to experiment with interest	5	12	18	44	12	29
Other colleges are adding	2	5	24	59	10	24
Other	3	7	3	7	6	15

Noncredit administrators were also asked about the importance of the factors in their decision to adopt PV skills training. The noncredit survey included an additional category, “do not know” than the credit survey options. Table 28 displays the areas noncredit administrators identified as important to their adoption decisions.

Table 28

Importance of Factors in the Noncredit Administrator Adoption Decision (N = 30)

Factor	very important		somewhat important		not important		do not know	
	n	%	*n*	%	*n*	%	*n*	%
Funding for equipment	26	84	3	10			1	3
Availability of qualified faculty/adjunct	26	84	2	6			1	3
Skills lead to student employment	27	87	2	6			2	6
Faculty adjunct technical skills	25	81	4	13			1	3
Faculty/adjunct willingness to develop course	24	77	5	16			1	3
Faculty/adjunct willingness to teach courses	23	74	6	19			1	3
Area business requested	22	71	4	13	3	10	1	3
Expect students to enroll	18	58	9	29	1	3	2	6
Personal philosophy of college responsibility	16	53	8	27	5	16	1	3
External funding available	16	53	12	39	1	3	1	3
Advisory board suggested	15	48	10	32	2	6	3	10
Personal philosophy important to students	11	35	11	35	7	23	1	3
Want to experiment with interest	10	32	16	52	3	10	1	3
Administrator suggested or required	8	26	15	48	5	16	2	6
Technology is exciting	7	23	8	26	13	42	2	6
Will become a requirement in NCCCS	6	19	15	48	5	16	4	13
Other colleges are adding	2	6	14	45	12	39	1	3
Other	1	3					2	6

There was agreement between the administrators as to the importance of the factors in their decisions to adopt PV skills programming. The credit and noncredit administrators cited the same seven top factors as very important: faculty adjunct technical skills, availability of qualified faculty/adjuncts, funding for equipment skills, lead to student employment, faculty/adjunct willingness to develop and teach courses, and area businesses requesting the training.

Is There a Relationship Between Information Cited as Important for Adoption by Administrators from the Same College?

Administrators were asked to rank the importance of factors in their decision to adopt PV skills training as very important, somewhat important, or not important. (The noncredit survey included an additional category of "do not know.") Of the 21 colleges with a credit and noncredit respondent from the same college, there were 16 pairs that were both aware of PV skills training. One administrator did not answer the survey question on factors important for adoption from the 16 (answered it was very unlikely the college would offer PV skills training programming) bringing the matched pairs to 15. The administrators' rating of importance for each item was compared. If the credit and noncredit administrators from the same college selected the same rating for degree of importance, it was recorded as an agreement. Table 29 lists the frequency and percentage of agreement by administrators at the same college.

Table 29

Agreement of Paired Administrators on Importance of Adoption Factors (N = 15)

Factor	Agree *n*	Agree %	Disagree *n*	Disagree %
Funding for equipment	13	87	2	13
Availability of qualified faculty/adjunct	11	73	4	27
Skills lead to student employment	11	73	4	27
Faculty adjunct technical skills	11	73	4	27
Faculty/adjunct willingness to develop course	10	67	5	33
Faculty/adjunct willingness to teach courses	8	53	7	47
Technology is exciting	8	53	7	47
Area business requested	7	47	8	53
Administrator suggested or required[a]	6	43	8	57
Other colleges are adding[a]	6	43	8	57
External funding available	6	40	9	60
Advisory board suggested	6	40	9	60
Want to experiment with interest	6	40	9	60
Will become a requirement in NCCCS	6	40	9	60
Expect students to enroll	4	27	11	73
Personal philosophy of college responsibility	4	27	11	73
Personal philosophy important to students	2	13	13	87

Note. [a]One administrator in the pair did not answer this question and percentages are for 14 pairs.

In no case did administrators from all 15 pairs agree on the importance of a single factor. Thirteen pairs (87%) cited the same value of importance for funding of equipment.

There was a high percentage of agreement between administrators at the same college for the importance of availability of qualified faculty/adjunct (73%), skill lead to student employment (73%), and faculty/adjunct technical skills (73%). The greatest differences between college pairs were for the factors “My personal philosophy of what is important to students” (13%), “My personal philosophy of our college responsibility to our community” (27%), and “Expect students to enroll” (27%).

Items cited as the most important by the group of credit administrators and by the group of noncredit administrators were also the items most commonly agreed upon by pairs of administrators in the same college.

Is There a Relationship Between Information Cited as Important for Adoption and College Enrollment?

The relationship between information cited as important for adoption by administrators and college enrollment was considered. The information was divided into internal and external influences as suggested by Lattuca & Starks’ (2009) curriculum model. The internal information included nine categories of all faculty related issues, funding, supervisors/administrator issues, expected student enrollment, philosophy of importance to the community, and interest in the technology. The external information category included six categories of college actions, external funding sources, area business influence, advisory boards, and skills leading to employment. Two categories were excluded due to low response rate, student interest and personal philosophy of importance to students.

The relationship between the importance of external and factors on adoption and credit enrollment is shown in Figure 5. Most administrators ranked the external factors between very important (3) and somewhat important (2) regardless of their college's enrollment.

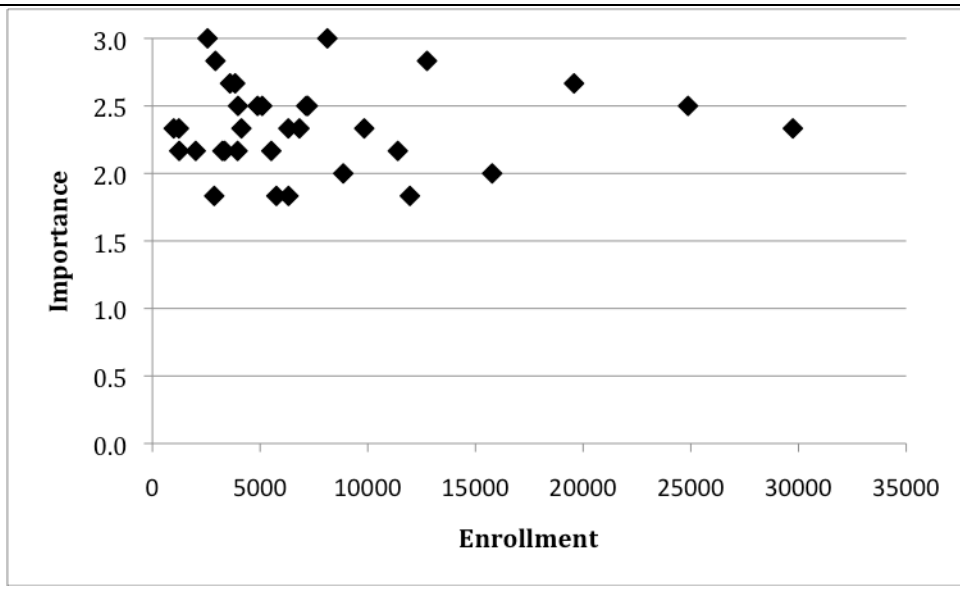

Figure 5. Importance of external factors for adoption of PV skills training.

The relationship between the importance of the internal factors on adoption of PV skills training and credit enrollment is shown in Figure 6. The internal factors were rated as slightly more important than the external issues, with rankings for most enrollments closer to the very important (3) range than the external issues.

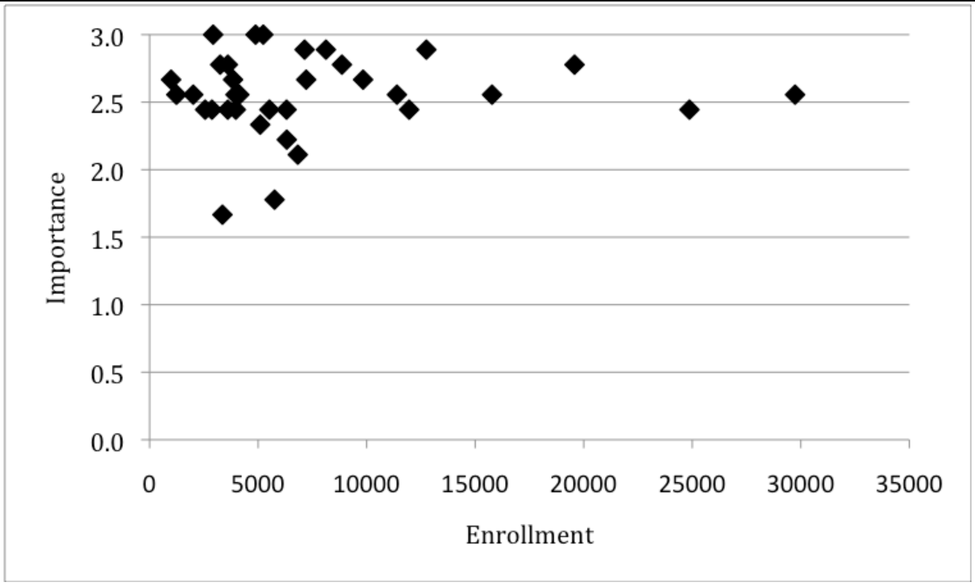

Figure 6. Importance of internal factors for adoption of PV skills training.

The relationship between the importance of external factors on adoption and noncredit enrollment is shown in Figure 7. Most administrators ranked the importance of external factors as between very important (3) and somewhat important (2) at all enrollments.

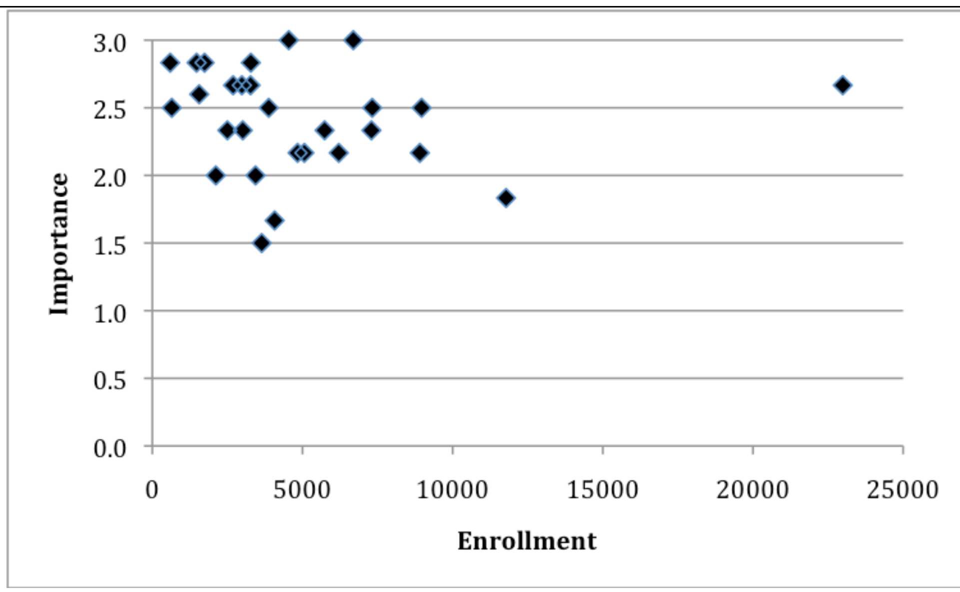

Figure 7. Importance of external factors for adoption of PV skills training.

The relationship between the importance of internal factors on adoption and noncredit enrollment is shown in Figure 8. The internal factors were rated as slightly more important than the external issues, with rankings for most enrollments closer to the very important (3) range than the external issues.

The credit and noncredit administrators rated the importance of internal information as slightly more important than external information. There was no clear pattern of relationship with enrollment.

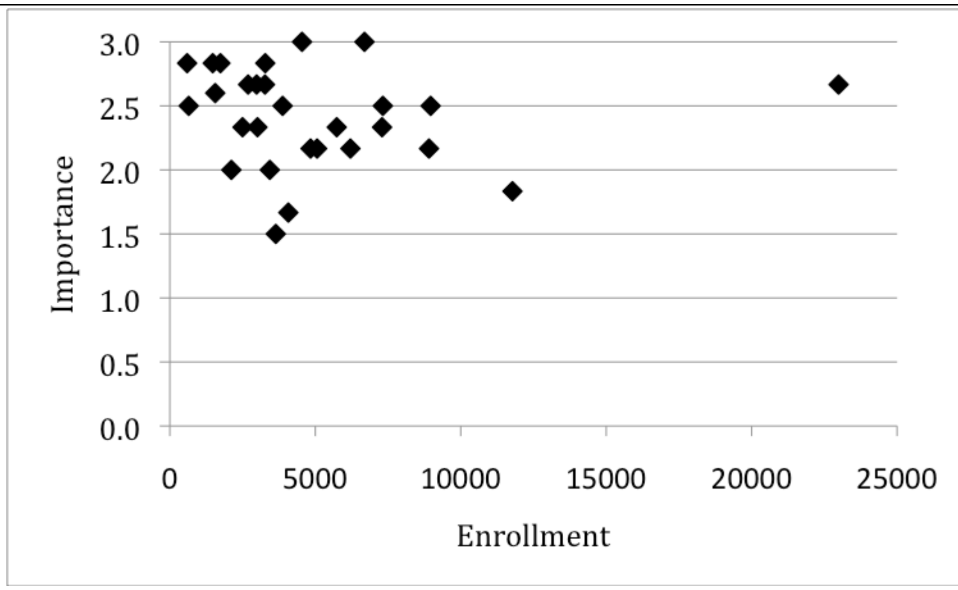

Figure 8. Importance of internal factors for adoption of PV skills training.

Summary

The purpose of the current research was to understand the factors related to PV educational programming decisions, including awareness of the need for and the adoption of PV skills training into the technical educational programming of the community colleges. Awareness was greater than 90% and the adoption rates were approximately one-third of the awareness rates. Paired college administrators at the same college became aware at different times and from different sources of information. Greater enrollment was moderately related to credit administrator awareness, sources of awareness, and adoption of primary PV skills classes.

Over 90% of credit and noncredit administrators were generally aware of PV skills training. The frequency of awareness was lower for more specific knowledge of training organizations, certification, and accreditations. More than 40% of administrators became aware of PV skills training over three years earlier. Administrators in the same college did not become aware at the same time, and there was not a pattern of credit or noncredit administrators becoming aware first in paired samples. There was no relationship observed between awareness and administrator background. Colleges with larger enrollment were somewhat more likely to have been aware of PV skills training for more time than colleges with smaller enrollments for credit administrators. Enrollment was not associated with awareness for noncredit administrators.

Administrators became aware through impersonal and interpersonal methods. News reports and the NCCCS Code Green and Super CIP had the greatest frequency of citations as a source of learning. Impersonal sources were more frequently cited than interpersonal sources. Credit and noncredit administrators in the same college learned about PV skills training from mostly different sources. The Code Green and CIP were the most common sources of learning but for approximately one-third of the paired colleges. There was a moderate positive relationship for the number of sources cited for awareness and enrollment for credit administrators but not for noncredit administrators.

PV skills training, as the primary topic of a course or as topic added to another course, was adopted by more than half of the 58 North Carolina community colleges in credit and noncredit areas. Approximately one-third of credit and noncredit administrators reported adding PV skills training into other courses. The electrical and sustainabilities curriculum were the most common credit areas for PV skills added to existing course. Noncredit courses with PV added skills used many different names selected by the local college. The frequency for PV primary course adoption was approximately a third for noncredit courses and 20% for the credit courses. Most administrators reported it was very or somewhat likely they would offer or continue to offer PV skills training courses in the future, indicating the likelihood of an increasing adoption trend. Twelve percent of credit administrators and 3% of noncredit administrators were very unlikely to add PV skills training classes in the future.

Credit and noncredit administrators were consistent in rating the importance of factors in their adoption decisions. Faculty skills, availability, willingness to develop and teach courses, and funding for equipment were of equal concern to the administrators but not necessarily at the same college. There were no clear pattern of relationships between the importance of internal and external factors and enrollment for credit and noncredit.

CHAPTER 5: DISCUSSION AND RECOMMENDATIONS

Administrators in community colleges play a key role in the decisions to adopt or reject educational innovations and as a result are the gatekeepers of educational innovations reaching students. Educational innovations are ideas new to administrators. The innovation-decision process of the diffusion of innovation model describes how administrators become aware of educational innovations and make adoption or rejection decisions (Rogers, 2003, pp. 168-218). In the specific case of educational curricular innovations, the academic plan model assists with conceptualizing curricula as an academic plan with internal and external influences as the issues administrators are exposed to in their innovation-decision making process (Lattuca & Stark, 2009). The diffusion of innovation model describes the general process and conditions for diffusion of innovations. Educational innovations diffuse through social systems, over time, and through impersonal and interpersonal communication channels (Rogers, 2003). The current research explored how PV skills training as an educational innovation is diffusing through the NCCCS, through different communication channels over time.

The current study was based on surveys of the credit and noncredit administrators of the North Carolina community colleges and on enrollment data from NCCCS Data Warehouse. Data were analyzed using descriptive and statistical analysis. The current study provides important descriptive data on awareness and adoption of PV skills training in the NCCCS.

The current research explored the NC community college administrators' awareness of PV skills training, how they became aware, degree of adoption, and reasons for adoption of PV skills training. The data collected were analyzed for the importance of factors at different stages of the innovation-decision process of the diffusion of innovation model. This chapter reviews the rates of awareness, sources of information of awareness, adoption, and reasons for adoption. Observations and recommendations are offered for increasing the rate of awareness and adoption for PV skills training and future educational technology innovations throughout the technology training of the NCCCS.

Discussion

Awareness of PV Skills Training

The first step of the innovation-decision process is knowledge. Knowledge can be divided into categories of general awareness, how-to-knowledge, and principles knowledge. Awareness knowledge is having information that the innovation exists. General awareness knowledge may motivate an administrator to seek out additional detailed information on how to use and apply PV. How-to knowledge is having information on the existence of the innovation and some additional information on how to use the innovation. Principles knowledge follows the general awareness and how-to stages, including information on how the innovation works (Rogers, 2003, pp. 172-174).

The current research measured a high level of general awareness, over 90% for credit and noncredit administrators, and a lower percentage in each of the next levels of awareness of specific PV skills training organizations (credit 88% and noncredit 77%), PV skills training certifications (credit 48% and noncredit 63%), and PV skills training accreditations (credit 29% and noncredit 24%). There is an increasing emphasis on aligning PV skills training programs with nationally recognized certifications (White, Dresser, & Rogers, 2010). The NCCCS administrators more specific knowledge of certifications and accreditations was much lower than their general PV skills training awareness. As employers give hiring preference to workers with PV skills certifications from accredited training organizations, administrators will likely become more aware and consider adopting PV skills training certifications and accreditations into their programs.

The diffusion of innovation model suggests awareness occurs over a period of time. The model predicts adoption rates will approach a bell-shaped curve over time, which when plotted as a cumulative adoption rate resembles an S-shaped curve (Rogers, 2003, p. 275). The model does not predict a bell-shaped curve pattern for awareness, possibly because most diffusion of innovation studies focus on explaining the pattern of already adopted innovations. Earlier diffusion studies have suggested the time distribution of awareness does follow a bell-shaped curve over time (Beal & Rogers, 1960, p. 10). In the current study, the innovation of PV skills training is at an early stage of adoption and there are more data on awareness than adoption practices. The cumulative awareness of general PV skills training over time by credit and noncredit administrators is shown in Figure 9. The cumulative data from the last six years approaches an S-shaped curve suggesting general awareness will be near 100% in the next few years. The first adoption of PV skills training recorded by the NCCCS Data Warehouse was the credit ALT 220 in the 2010 spring semester and the noncredit EGY 3002 in the 2010 summer semester. The first adoption occurred at 60% – 80% general awareness by administrators. Considering a typical one-year planning and implementation period, the first adoption decision probably occurred near 50% of administrator system wide awareness in 2009. Curriculum developers should plan for a period of rising awareness within colleges and across the NCCCS before adoption of the new technology training will take place. Additional research is needed to relate the history of awareness over time to the future adoption patterns.

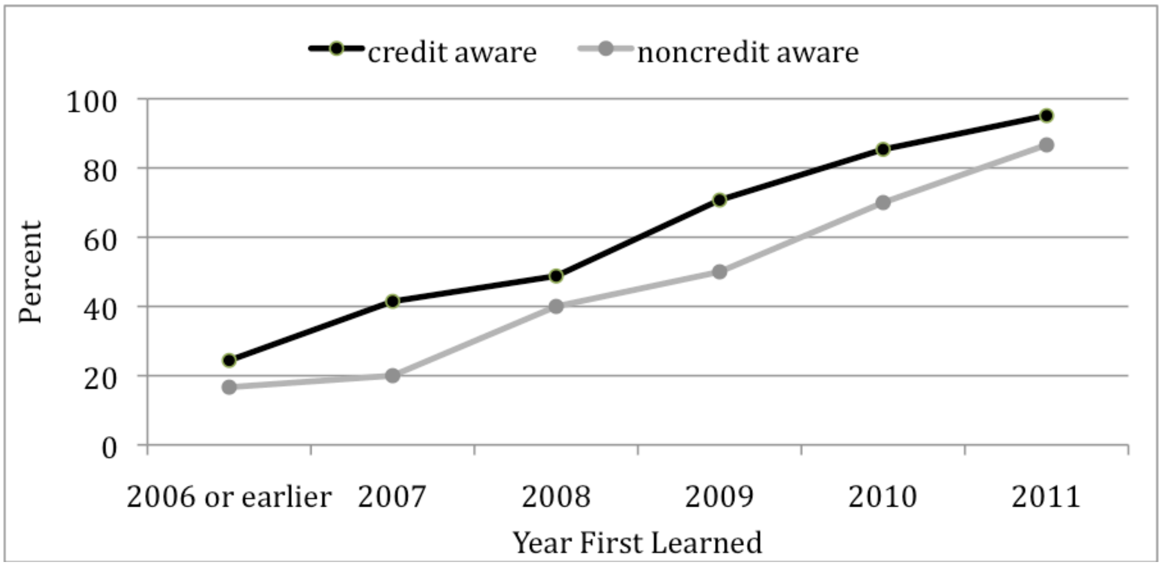

Figure 9. Cumulative percentage of general awareness of PV skills training.

The diffusion of innovation model suggests time of awareness is related to characteristics of the decision maker. Earlier awareness is associated with more formal education and more diverse work experience than later awareness (Rogers, 2003, p. 174). The current research asked if there were a relationship between awareness and highest earned degree and to what extent administrators had worked in other settings before their current employment. Awareness was highest for administrators with a master's degree (96%) and slightly lower with a doctoral degree (88%). The numbers of bachelor's and associate's degree holders were too small for comparison to the higher degrees. In the current research, the association of more awareness with more formal education was not supported. The awareness was almost the same—93% versus 90%—for administrators having worked at other than their current college and those having worked only at their current college. Overall the current research did not find an association between awareness of PV skills training and administrator employment history. The association of earlier awareness and highest earned degree might be more influenced by the subject of the degree, rather than the degree level, and by type of previous employment history rather than simply the length of time employed elsewhere.

Differences in awareness were also considered between credit and noncredit administrators working at the same college. Administrators at the same college learned about PV skills training at different times. The difference ranged from credit administrators learning about PV skills training four years earlier than their noncredit counterpart, to noncredit administrators learning about PV skills training five years earlier than their credit counterpart at the same college. There was only one college (6%) where the credit and noncredit administrators became aware of the innovation at the same time, and in this case both learned over five years earlier. There was not a pattern of credit or noncredit administrators learning earlier than the other. Averaging across all administrator pairs, the paired credit and noncredit administrators as a group learned at approximately the same time, but the average does not provide a true picture of what is actually occurring in individual colleges. The different learning mechanisms and times of credit and noncredit administrators' awareness suggest two separate processes occurring in colleges around occupational skills training. If the credit and noncredit awareness and adoption decisions were synchronized, and a coordinated effort was in place for the two groups for occupational training programs, colleges would likely ensure the earliest awareness of new technology training needs, sometimes as much as five years earlier.

The very large percentage of paired colleges learning about the same occupational skills training need years apart suggests that different administrators overseeing the development of training for occupational areas are disconnected and potentially working independently rather than cooperatively within the same college. A lack of coordination could result in duplication of services and faculty, differing quality standards and learning objectives, ineffective use of materials and equipment, and no articulation agreements for noncredit to credit classes on the same subject. The disconnection between credit and noncredit administrators could also result in lack of services to either the credit or noncredit students.

The bigger question may be why there are two different administrators overseeing the development of new occupational skills training for the same occupations. The credit and noncredit organizational structure of many colleges may be driven more by internal budgeting structures or tradition than by constituent need. Integrated organizational structures for credit and noncredit areas have been suggested as a method to improve the coordination between the credit and noncredit programs. For example, in 1993, Central Piedmont Community College began integrating noncredit programs into credit departments and Craven Community College has also integrated noncredit programs into credit departments. Both combined credit and noncredit programming to increase efficiency by reducing administrative positions and encouraging resource sharing (Van Noy, Jacobs, Korey, Bailey, & Hughes, 2008, p. 34).

The current research found a moderate positive correlation between years of awareness and enrollment for credit but not for noncredit administrators. Enrollment is related to the population and business base of the college's service area. A larger business base increases the probability of having more of the occupations impacted by PV located in the service area and the resultant need for employees with PV skills training in the service area. Larger colleges also have larger numbers of faculty and administrators increasing the possibility of an administrator becoming aware of PV skills training needs. There was not a correlation between years of awareness and enrollment for noncredit administrators. The lack of a correlation may be because noncredit administrators have a more varied but less technical background than credit administrators. Fifty percent of the noncredit administrators reported having worked outside of education in areas such as health care and the military.

Sources of Awareness of PV Skills Training

The current research investigated how educational leaders became aware of PV skills training. Awareness is acquired through communication channels. The communication channels can be impersonal sources, such as the media, and interpersonal sources, such as peers. Different types of communication are theorized to be more important for individuals at different stages of the innovation-decision process. For example, the model suggests impersonal communication, such as media reports, is more important for early adopters, and interpersonal communication is more important for later adopters (Rogers, 2003, pp. 211-212).

Administrators reported the highest frequency of learning about PV skills training from news reports, the NCCCS Code Green project, and the Code Green CIP. NCCCS Presidents initiated the Code Green project in January 2009 to promote sustainability in all educational programs through the state curricula and on the college campuses. One of the Code Green projects was a CIP designed to assess the current status of sustainability in occupational courses and to develop new courses to promote sustainable practices ("CODE GREEN initiative," n.d.). The current research was conducted at the end of the second year of the two-year CIP. Fifty percent or more of all educational administrators reported learning about PV skills training from the Code Green project, and 54% of the credit administrators reported being aware of PV skills training from the CIP. The CIP involved hundreds of credit faculty and administrators in web-based meetings, face-to-face meetings, visits to other college campuses, and email exchanges. Noncredit faculty and administrators were not formally included in the CIP meetings. The mixing of ideas between credit peers from different colleges is a method of interpersonal communication and the CIP might have been better categorized as both an impersonal and interpersonal method of gaining information about PV skills training. The peer network developed can assist administrators at earlier stages of awareness and decision making to use the knowledge gained from the piloting of PV skills training done by their peers. Some noncredit administrators heard from their credit colleagues about the work of the CIP, but noncredit educational administrators were not directly involved.

The most frequent interpersonal sources of information for credit administrators were curriculum instructors. For the noncredit administrators it was speakers at a meeting and continuing education instructors. A credit respondent emphasized the role of the curriculum instructors in the awareness process: "Being new in my role, I am learning the process. My instructors and I have had conversations concerning PV and the importance of integrating into the curriculum." The difference in the sources of information for credit and noncredit administrators may play a role in why administrators at the same college learned about PV skills training at different times. The noncredit administrators had a very low percentage learning from curriculum instructors (18%). The credit and noncredit administrators learned from continuing education instructors at approximately the same percentage (credit 26%, noncredit 29%). This may point to a lack of shared technical expertise and duplication of faculty between the credit and noncredit areas of the colleges.

Beyond the Code Green and CIP, the credit and noncredit administrators did not report a high percentage of common sources of awareness. This split of information at the local and state level points to an important issue in the diffusion of PV skills training awareness. The occupational need for the PV skills training is the same, yet the two areas of the colleges responsible for reacting to this need with technical training learn about the needs differently and at different times.

The diffusion of innovation research has reported more and earlier adoption from larger organizations (Rogers, 2003, p. 288). Enrollment was used as an indication of the size of the colleges studied. There was a moderate correlation of years of awareness with greater enrollment for credit administrators but not for noncredit administrators. One possible explanation is that the college enrollment data is a better representation of the size of the student body and the college programs than the noncredit enrollment data. The credit enrollment data used was unduplicated headcount for all curriculum areas. Occupational students make up an increasing percentage of curriculum students. Nationally 64% of associate degree students and 81% of certification degree students majored in occupational fields (Hirschy, Bremer & Castellano, 2011, p. 297). Occupational enrollment was a smaller percentage of the total continuing education enrollment, just 35% in North Carolina in the 2010-2011 year (North Carolina Community College System, 2012a).

There was a difference in the total number of sources of awareness cited for credit and noncredit administrators. The mean number of sources cited for the credit administrators was 5.7 (*SD* = 4.7, range 0 – 22), and for the noncredit administrators the mean was 3.8 (*SD* = 2.6, range 0 – 9). Noncredit administrators on average cited approximately one-half of the sources of PV skills training of the credit administrators. The difference may be due to the different educational and technical backgrounds of the credit and noncredit administrators. The credit administrators may have more depth but less breadth of responsibility for technology areas. This suggests credit administrators may be more knowledgeable and seek out a wider variety of information on technology skills training details and content than their noncredit peers.

Adoption of PV Skills Training

Thirty (52%) of the NCCCS colleges in the current research have adopted some type of PV skills training in the credit or noncredit areas. Courses with PV as a primary topic have been adopted in the credit areas by 21% of the 58 NCCCS colleges and in the noncredit areas by 35% of the colleges responding to the survey. Courses with PV as an added topic into courses have been adopted in the credit areas by 36% of the responding colleges and in the noncredit areas by 39% of the responding colleges. This is an impressive amount of adoption within the last three academic years. Figure 10 shows the number of classes offered over the last three years for the two PV primary courses offered to students, ALT 220 for credit and EGY 3002 for noncredit.

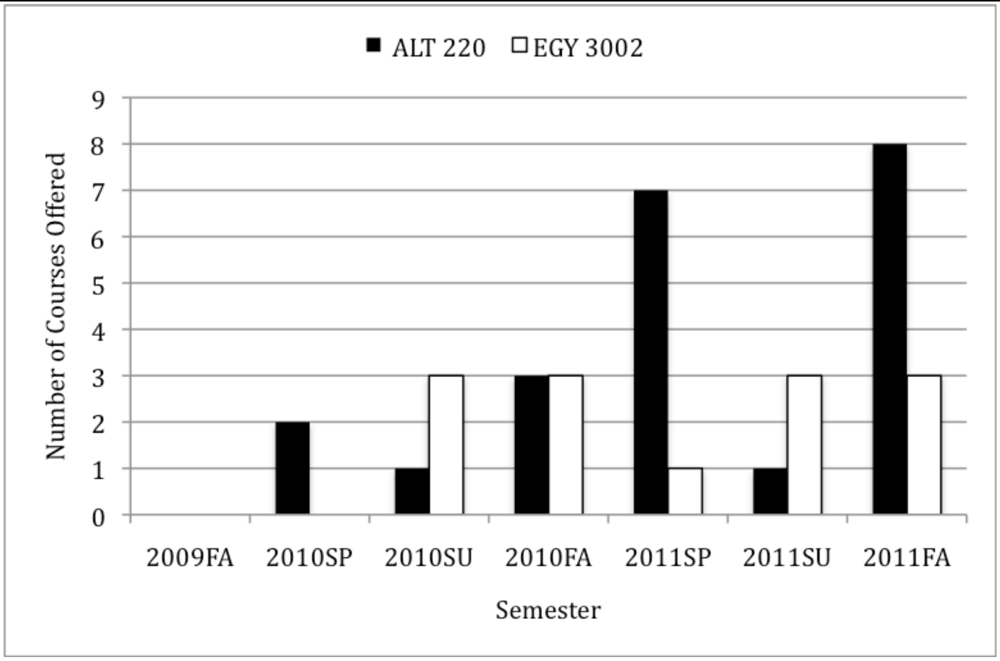

Figure 10. Number of PV primary courses offered by semester.

The number of ALT 220 PV-specific classes has continued to grow since its first introduction in the 2010 spring semester. With the exception of summer semesters when colleges do not receive FTE funding by the NCCCS, the number of classes has grown almost every semester. The noncredit EGE 3002 PV-specific class appears to be offered at a constant rate. Thirty-five percent of the noncredit administrators reported offering a PV primary skills class, and it is assumed the actual number of the noncredit PV primary classes created is greater because they used a different course number and name.

Adoption of PV skills as a primary or added topic varied by credit program area from the greatest of 40% for Associate Electrical Engineering Technology to the lowest of 11% for the Associate Building Construction Technology. Certificates can be added relatively quickly to the curriculum, in approximately one year. A Photovoltaic Certificate in the Electrical/Electronic Technology degree is in the approval process now for the 2013-14 academic year for inclusion in the state education catalog (A. McMahon, personal communication, April 2, 2012).

The ALT 220 Photovoltaics course can be added to a college's approved credit Program of Study in approximately one year if the ALT prefix is approved for the other major hours in the Curriculum Standard for the program ("North Carolina Community College System, 2012c). PV skills training has been adopted as a primary (35%) or as an added skill to existing courses (39%) in approximately the same percentages in the noncredit area. The process for adding PV into noncredit courses is faster and at the same time more difficult to track statewide because of the continuing education process of creating courses. Continuing education has flexibility to develop a program at anytime when a community need is identified. The continuing education administrator can develop the outcomes and competencies for the class. If the class is not on the state Master Course list, it must be approved by the Workforce Development Leadership Committee at the state level (North Carolina Community College System, n.d.).

The 18 different course titles mentioned by the noncredit administrators in the survey is evidence of the large number of different titles and content being created in the same subject area. The noncredit courses can articulate to the credit programs with if local college agreements are adopted. Local articulation data were not collected and is an area of potential future research. The large number of similar course titles may be seen either as evidence of the variety of ways to meet local needs or as an inefficient creation of the same content by multiple colleges. The different approval processes are a possible reason for the difference in the rate of adoption by the credit and noncredit areas and for the difference in how the administrators in the two areas learn about new technologies.

The parallel structure of the credit and noncredit program areas for occupational skills training in many colleges is effective for development of courses in credit and noncredit areas respectively, but not as effective for working or learning together to adopt a new educational technology training program.

Adoption of PV skills training is in the early stages with approximately one-fifth to one-third of colleges adopting PV primary courses in credit or noncredit areas, and one-third adopting a PV add-on skills course in credit or noncredit areas. Taken all together and considering all of the Data Warehouse adoptions and the survey responses, over 50% of the NCCCS have adopted at least one primary or add-on PV skills training course in a credit or noncredit area. The over 90% awareness suggests the percentage of colleges adopting PV skills will continue to grow. Eighty percent of credit administrators and 90% of the noncredit administrators reported they were very likely or somewhat likely to offer or continue to offer PV skills training as a primary topic or as an add-on topic to existing classes. There were only seven colleges reporting adopting PV skills training in the both the credit and noncredit areas, raising the question of lack of coordination between the two areas.

Five credit respondents and one noncredit respondent reported they were very unlikely to add PV primary or PV skills added courses in the future. The six administrators were from colleges where PV had not been adopted in credit or noncredit courses and the enrollment was less than 6,000. The factors behind their "very unlikely" response may be due to other factors not evaluated in the current research. Rogers (2003) classified the last group to adopt an innovation as "laggards" (pp. 284-285). Rogers (2003) describes laggards as,

> …near isolates in the social networks of their system. The point of reference for the laggard is the past. Decisions are often made in terms of what has been done previously, and these individuals interact primarily with others who also have relatively traditional values. Laggards tend to be suspicious of innovations and of change agents. (p. 285)

Laggards have been found to make up approximately the last 16% of the adopters over time, the same percentage as the combined innovator and early adopter categories (p. 281). The six administrators represent nine percent of the total respondents, somewhat less than Rogers' model predicts. The important point is that administrators will take varying times to adopt new educational innovations and this should be expected and planned for. The number of adopters over time approaches a normal curve, and understanding and planning for this distribution may be useful when considering how educational innovations are adopted across the North Carolina community colleges. Laggards are the last to adopt, but the positioning is not inherently negative. Some innovations have serious negative effects that only the laggards recognize. While awareness of PV skills training may approach 100%, PV skills training primary or added skills courses will most likely not be adopted by 100% of the colleges in the credit or the noncredit areas.

Influences on Adoption Decisions

The reasons cited for adoption of PV skills training were similar for the credit and noncredit administrators, both citing faculty and funding as some of the most important issues. Very few administrators cited other colleges adopting PV skills training as important in their decisions (credit 5%, noncredit 6%), suggesting the importance of local decision making to meet local occupational training needs. Advisory boards were rated as very important by only 56% of credit administrators and 48% of noncredit administrators. This is a surprising low percentage if local occupational training needs are primary factors in making local decisions. The low percentage suggests other factors, possibly personal opinions of administrators as a factor in curriculum decision making. Strong connections between community college program development and local businesses assure students are acquiring the skills needed by the employers. Miami Dade College (MDC) partnership with Florida Power and Light (FPL) is an example of how occupational training and employers can be tightly integrated. MDC created the Nuclear Maintenance Apprentice Training Program in collaboration with FPL, as a professional training pipeline. At least twenty students graduating per year from the two-year program are expected to be employed by FPL (Miami-Dade College, 2008). The North Carolina Community Colleges could set up similar apprentice or other tightly connected training programs with businesses for PV skills training courses.

The current research compared sources of information used by administrators from the same college to make adoption decisions. Availability of qualified faculty, faculty technical skills, and funding for equipment were the most-cited areas by credit and noncredit respondents as very important in their decision to adopt PV educational programming. Although over 50% of all administrators were aware of the Code Green project, only five of the sixteen paired administrators both reported learning about PV skills training from Code Green. Credit and noncredit administrators' proximity to each other on the same campus begs the question of why more pairs of administrators are not learning from similar sources. One possible reason for the different learning and decision making is the administrators responsible for responding to occupational training needs often report through different administrators with different funding streams and priorities.

The research also considered the relationship between methods cited as reasons for adoption and enrollment. The information was categorized as internal or external influences to the curriculum plan. The internal information category included faculty related issues, funding, supervisors/administrator issues, expected student enrollment, philosophy of importance to the community, and interest in the technology. The external information category included actions by other colleges, external funding sources, area business influence, advisory boards, and skills leading to employment. There were no clear patterns of differences between internal factors and enrollment or between external factors and enrollment for credit or noncredit administrators. There was a moderate correlation found between credit administrator awareness and enrollment, and the credit administrator total number of awareness sources cited and enrollment, but a similar relationship with enrollment was not observed for noncredit administrators.

There was one open-ended question on the credit and noncredit administrator surveys. The comments identified examples of external factors being considered by the administrators. A credit survey respondent wrote of two companies with PV as their primary business moving into the college's service area and considering the PV in the local college's curriculum as important to workforce development. A noncredit respondent mentioned two solar farms and a company producing solar panels locating in their service area. Noncredit respondents cautioned, "There are not jobs" and warned not to "hop on this like another flavor or the month." Another noncredit respondent went further: "This effort (green technology) feels too much like Biotechnology where every college jumped on the bandwagon and started offering biotech courses. Now we are left with a few colleges that are still offering biotechnology." The history of the development and results of the biotechnology program, introduced to the NCCCS in 2005 and with a similar system-level push through the North Carolina Community College Bio-Network (North Carolina Community College System, 2010), would be a useful case study to evaluate how the NCCCS became aware of and promoted the adoption of training programs for biotechnology as a technology innovation. The respondent comment suggests the employer demand was not realized and the biotechnology training programs were later dropped by some colleges. There were 783 students in 29 (50%) colleges registered in the Biotechnology major in 2010-11 academic year, a similar percentage of colleges with some type of PV skills training (North Carolina Community College System, 2012a).

A noncredit respondent suggested in the open-ended questions, "If Green is to be done it should be done as a stand alone program." This is one opinion of how sustainability topics should be introduced into the NCCCS system. A more conservative method is to add the topic into existing courses. Other research has shown states with more installed PV capacity favor stand-alone programs rather than add-on topics (Ventre & Weissman, n.d.). The question of which is the best method to develop PV skills training and other technology courses is one of continuing debate.

Conclusions

Awareness of PV skills training is over 90%, and 50% or more of administrators expect to offer or add PV skills training courses in the future. The NCCCS Code Green project and the CIP were major sources of awareness of PV skills training. Over 35%

percent of colleges participating in the survey have adopted courses adding PV skills into existing credit or noncredit courses. Twenty-one percent have added PV primary skills classes into the credit areas and 36% have added PV primary in the noncredit areas. Across the state system, 52% of the colleges have adopted some type of PV skills training.

The Code Green project and the Code Green CIP were cited as important factors in learning about PV skills training. Adoption decisions were influenced by faculty training and qualifications, and funding issues. Recommendations include continuing the Code Green CIP to provide time for adoption and implementation of the PV skills training and other sustainability topics by the NCCCS colleges.

Advisory boards were reported as less influential in adoption decisions than was expected. New technologies will continue to change the skills needed by businesses and community college administrators must create systems to keep them aware of the new technologies and to implement new training to support the new technologies. Close relationship with advisory boards is an important method to assure coordination of occupational training and jobs. The NCCCS and the local colleges can take action to improve the early awareness, using the strength of the state system to diffuse the information through administrators responsible for making curriculum decisions. Individual colleges can also improve their responsiveness to business training needs with credit and noncredit administrators working together or by combining occupation training under a single administrator to oversee the occupational training needs in both the credit and noncredit program areas.

Recommendations

The 58 eight colleges of the NCCCS are linked by state law, a centralized administration, state policies, and a common funding formula. A strength and weakness of the NCCCS is the ability to make local adoption decisions based on local needs and local administrator information. Three recommendations are made to further the effective awareness and decision process for new educational technology innovations at the state level. A fourth recommendation is made for local administrators at individual colleges. First, the NCCCS should create and facilitate a continuation of the Code Green – CIP by creating a network for ongoing information and exchange to encourage adoption. Second, create a technology dean group similar to the CFO and CAO groups, to enhance information flow across NCCS of new educational technologies impacting occupational education. Third, occupational technology training should be coordinated between credit and noncredit areas of each college to improve response time, consistency, and effective use of college resources. A fourth recommendation is for credit and noncredit administrators to reach out beyond their local resources to learn about the new technologies that are occurring in other areas.

The first recommendation is for the NCCCS to create and facilitate a continuation of the Code Green CIP by creating a network for ongoing information and exchange to encourage adoption of PV skills training. The Code Green Project and the Code Green CIP were widely recognized among the administrators participating in the current research. The CIP process was both a method of awareness and a source of communication for and among administrators at different stages of awareness and adoption of PV skills training. The CIP was an active tool for curricular change because it identified and highlighted innovative curricular practices. The CIP leaders acted in a dual role of consensus builder across colleges and change agent to colleges. This dual nature of the CIP process could be developed and refined in future CIPs to maximize the effectiveness of both roles, awareness and as an agent of change.

The CIP adoption and implementation process is underway and will be in process for the next year or more. Many administrators would benefit from continued peer interactions with the colleges that have already adopted PV skills training. An inventory of PV primary and add-on courses by college, syllabi, and course content, maintained by the NCCCS, would be beneficial for all administrators. A course inventory and shared course material would increase awareness of what courses other colleges in the system are offering and would decrease adoption time by providing standardized course content. The syllabi and course content would be particularly useful to noncredit administrators to reduce their development time for PV skills training and to increase the overall quality of the courses. The first college adopters have already implemented PV skills training and other colleges will need the adopters as peer case studies for support. The Code Green CIP should not end with the recommendations made, rather it should continue through the implementation period over the next year or more. The continuation of the CIP should also include the development of a state level certification and accreditation program for PV skills training that individual colleges could adopt. A statewide process to introduce new technologies into the noncredit areas, similar to the CIP in the credit area, is a suggested to provide faster and more consistent noncredit course development for new technologies across the 58 NCCCS colleges.

The second recommendation is for the NCCCS to create a focus group of advanced technology administrators to reduce the time of awareness and adoption of future new educational technology innovations. The current research created an email list of administrators responsible for new technology curricula. The list could be refined and made into an established group of credit and noncredit applied technology department chairs or deans similar to other established groups of administrators with common areas of interests such as the Chief Academic Officers or Chief Financial Officers. The new advanced technology dean group would have the objective of speeding the flow of information and experience on new technology topics into the educational programs. Ideally the group would include credit and noncredit deans, when they are located in different parts of the college, to increase the awareness across the credit and noncredit areas of the individual colleges and the state system of colleges.

The third recommendation is to improve coordination between credit and noncredit areas of the college in the area of occupational skills training. Occupational skills training should be organized under one function in the college, in the most technically knowledgeable area, which is typically the credit area. The current division of occupational training into two different functions with different interests and goals may be slowing the awareness and adoption of new technology training important for supporting business and economic development. This is a structural and financial issue at many colleges that could be changed to improve the speed and consistency of the development of new technology training.

The fourth recommendation is focused on how individual administrators at each college can improve their own awareness of new technologies with the potential to impact the occupational training needs of the area businesses. Administrators should keep in contact with their peers at surrounding colleges on a formal and informal basis to compare new ideas and challenges. Credit and noncredit administrators within colleges should reach out to each other and work towards a coordinated occupational training program development and sharing of resources, including faculty and equipment. Credit and noncredit administrators at individual colleges should consider creating one shared advisory board for occupational training and working closely with the advisory board and responding to board’s suggestions and requests.

Strengths and Limitations of the Study

The current study provides detailed descriptive data on the awareness and adoption of PV skills training in the NCCCS. The survey response rates of 71% for the credit administrators and 52% for the noncredit administrators exceeded the target of 50% considered typical for similar Internet-based surveys (Dillman et al., p. 282). The follow-up reminder emails effectively increased the response rate. This represents a high proportion of NCCCS technology administrators in the current research. The instrument development with the expert panel, think-aloud, and piloting increased the validity.

The traditional diffusion research methodology has been effective but has limitations include studying PV skills trainings alone instead of with a cluster of sustainability skills training, collecting data at a single point in time versus over a period of time, and using primarily quantitative data versus qualitative data. The quantitative data limited the potential for identifying new variables not considered in the original research design (Meyer, 2004). The adoption of PV as a stand-alone course is more easily measured with specific archival data than the addition of PV concepts into existing courses.

The enrollment data selected may be a weakness of the current study. Limiting the noncredit enrollment data to only regular budget and self-supporting occupational programs may not have been as good a representation of the noncredit area as the unduplicated headcount of all noncredit programs combined. In the credit areas, enrollment by program area impacted by PV occupational skills may have been a more targeted enrollment approach.

The formal organizational and informal relationship between the credit and noncredit areas of the colleges studied was not known. Information on the relationship between the groups at individual colleges would assist in understand how the differing relationships were related to awareness and adoption.

Significance of the Study

The current research informs community college leaders creating new technical educational programs, legislators determining funding for the community colleges, and local and state economic developers. The identification of PV curriculum practices in the North Carolina community colleges provides all colleges with additional information on a variety of methods to consider for potential PV technical educational curriculum. The current research establishes a statewide case study, which may be useful to other state and national studies of the diffusion of technology innovation into educational programming.

Future Research

Photovoltaics and other sustainability skills training programs are in transition as the economy changes and public attitudes evolve. The Code Green project and the Code Green CIP had a major impact on administrator awareness of PV skills training and other sustainable topics. The current research focused on the awareness and decision making of the educational administrators. The primary members of the CIP project teams were faculty, and additional research directly on faculty awareness of PV skills training would add insight into the overall process of awareness and adoption at the community colleges.

The Code Green CIP was the first CIP to cover multiple curriculum areas as compared to the CIPs for single academic areas in the past. Additional research on CIP with multiple programs areas would add information on the impact of faculty interaction between fields. Additional research on the method and process of the CIP itself would add data to how participants become aware of innovations and colleges use the information to create new programs or add technical training into existing courses.

Another area of additional research is to study the rate of diffusion of innovations into technical educational programming areas through statewide associations of faculty in similar fields. An example is the Association of Machining Instructors (AIMS), which hold meetings twice a year at colleges across the state. The meetings are used for viewing the facilities at different colleges, sharing new ideas such as National Institute of Manufacturing accreditation, and exploring potential grant opportunities.

Additional research on the interaction between credit and noncredit administrators within individual colleges and across the NCCCS would yield data on communication and working relationships within and between colleges. The current research pointed to the opportunity for more unified and coordinated efforts within and between colleges to become aware of new and changing technologies. Such an effort could potentially increase the efficiency of introducing new technologies and speed up the workforce development and resulting economic development of the state.

The current research focused on the earlier stages—awareness and decision—of the innovation-decision process. The diffusion process is ongoing and additional longitudinal research on the future on the later stages—implementation and confirmation—would add to a more complete understanding of the diffusion process of the PV workforce skills innovation.

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APPENDIX A : E-MAILS USED FOR THE QUESTIONNAIRE

E-mail Prenotification

Dear (person)

I am writing to ask for your help in understanding how your college is or is not adopting and/or integrating photovoltaics into credit (curriculum) and noncredit (continuing education) courses. The current research supports the Code Green project that many of you have been involved in as a Super CIP participant.

You have been selected for this survey because of your position as an educational administrator in educational areas potentially impacted by photovoltaics.

You will be receiving an email request from Deborah Porto at Haywood Community College, to fill out an Internet survey on how your college has or has not added or modified credit or noncredit courses with photovoltaics. She will provide detailed information on how to access and answer the questions in the survey. If you believe you are not the right person to answer these questions from your college please contact Ms. Porto at dporto@haywood.edu or 828-627-4632.

Thank you for your help to improve the North Carolina Community College educational programs.

Dr. Rose Johnson
Dr. Rusty Stephens

Email Survey Request from Researcher

Dear Community College Educational Leader,

Community Colleges work to meet the current and future needs of our students, businesses and our communities. An important area for these stakeholders is understanding and using new and changing technologies.

I am writing to ask for your help in understanding how your college is considering or is not considering adopting and/or integrating photovoltaics into credit (curriculum) and noncredit (continuing education) courses. The current research supports the Code Green project that your college may have been involved in with the Super CIP sectors.

The survey will take approximately 10 minutes to complete. Your responses are voluntary and will be kept confidential. You have the right to decline or withdraw from the survey. Your names will not be added to any other mailing lists.

By taking a few minutes to share your knowledge and opinions about photovoltaic educational programs at your college you will be helping us to better understand the role photovoltaics is or is not playing in educational courses. There are no known risks to you for answering this survey. The deadline to complete the survey is December 15, 2011.

You may email the researcher at dporto@haywood.edu for a copy of the summary of the results of the survey.

If you have questions about this survey please contact either Deborah Porto at dporto@haywood.edu or Dr. Meagan Karvonen, her dissertation chair, at karvonen@email.wcu.edu This study has been reviewed and approved by the Western Carolina University Institutional Review Board. If you have any questions about your rights as a participant in this study, you may contact the chair of the IRB by telephone at 828-227-7212.

I hope you enjoy completing the questionnaire and I look forward to receiving your responses.

Sincerely,

Deborah Porto
Dept. Chair Advanced Technologies
Haywood Community College
Doctoral Student at Western Carolina University

Follow-up Email Contact

From: Deborah Porto (dporto@haywood.edu)
Sent: Day, Month, Date, time
To: recipient
Subject : Code Green Research – second request

Dear First Name,

Recently, I sent you a letter asking you to respond to a very brief Internet questionnaire about how your college has added or included photovoltaics into educational courses. The questionnaire is short – 20 questions and should take less than ten minutes to complete.

If you have already completed the survey, I would like to thank you for your time, as your responses are very important to the Code Green Project. If you have not yet answered the survey, I would like to urge you to take a few minutes to do so. By sending this email with a link to the web site, I thought it might be easier to respond. Please respond by March 30, 2012

Thank you for your help. This questionnaire is important. It is one of the few ways available for getting accurate information about the programs at your college.

Sincerely,

Deborah Porto
Dept. Chair Advanced Technologies
Haywood Community College
Doctoral Student at Western Carolina University

Second Follow-up Email

From: Deborah Porto (dporto@haywood.edu)
Sent: Day, Month, Date, time
To: recipient
Subject : NCCCS educational administrator study

Dear First Name,

Recently, I sent you an email asking you to respond to a very brief Internet questionnaire. The questionnaire is part of my dissertation research on how community college educational administrators make educational programming decisions for curriculum and continuing education.

The questionnaire is short – 20 questions and should take less than ten minutes to complete.

If you have already completed the survey, I would like to thank you for your time, as your responses are very important. If you have not yet answered the survey, I would like to urge you to take a few minutes to do so. By sending this email with a link to the web site, I thought it might be easier to respond. Please respond by March 30, 2012

Please contact me if you have any questions about the questionnaire. I can be reached by email at dporto@haywood.edu or by phone at 828-627-4632.

Thank you for your help. This questionnaire is important. It is one of the few ways available for getting accurate information about the programs at your college.

Sincerely,

Deborah Porto
Dept. Chair Advanced Technologies
Haywood Community College
Doctoral Student at Western Carolina University

Third Follow-Up Email

From: Deborah Porto (dporto@haywood.edu)
Sent: Day, Month, Date, time
To: recipient
Subject : Please help me complete my NCCCS dissertation research

To - North Carolina Community College Leaders

I would like your help by completing the survey linked below. It is very important that each North Carolina Community College be represented in the survey results. You were specifically selected to participate because of your role at your college.

The survey asks questions about photovoltaics, but the issue being studied is how educational administrators make decisions on educational programming. Your experience and opinions are equally important if you have or have not had any experience with photovoltaics.

I will be following up with a phone call to answer any questions you may have.

Thank you very much for your help. Please contact me by email or phone if you have any questions or concerns.

Sincerely,

Deborah Porto
Dept. Chair Advanced Technologies
Haywood Community College
Doctoral Student at Western Carolina University
dporto@haywood.edu
828-627-4632

APPENDIX B : CREDIT QUESTIONNAIRE

NCCCS PV Skills - Credit

Q18 North Carolina Community College System Photovoltaic Skills Training Awareness and Adoption Survey - Curriculum Programs

The purpose of this survey is to learn if and how your college has considered or adopted photovoltaics skills training into curriculum courses and programs. The survey asks how and when you first heard (or have not heard) about the need for skills training on photovoltaics skills. <u>Your opinions are equally important if you have not yet considered or have decided not to adopt photovoltaics skills training.</u>

This survey supports the NCCCS Code Green and Super Curriculum Improvement Projects. Code Green is a North Carolina Community College System (NCCCS) initiative to develop and promote sustainable programs across all 58 NCCCs through educational programs and campus development. Photovoltaics skills training is a part of some sustainable programs.

You were specifically selected as an educational administrator to represent your college for this survey. It is very important for you to respond to the survey so your college will be represented. If you believe you are not the right person to answer these questions from your college please contact Ms. Deborah Porto at dporto@haywood.edu

There are two sections. The survey should take approximately ten minutes to complete. You can return to the survey if you exit.

Thank you very much for your help on this important project. As a token of appreciation for completing the survey, you many elect to receive a copy of the final report from this study.

Q20 To help us learn about our respondents, we would like to ask you a few background questions.

Q1 1. What is your title?
- ❍ Department Chair (1)
- ❍ Dean (2)
- ❍ Vice President (3)
- ❍ Other (4) ____________________

Q2 2. Please select the program or programs you directly supervised, or are part of the department/division you supervised in the 2011 fall semester.

- ❑ Building Construction Technology (35140) (1)
- ❑ Construction Management (35190) (2)
- ❑ Electrical/Electronics Technology (35220) (3)
- ❑ Electrical Engineering Technology (40180) (4)
- ❑ Electronics Engineering Technology (40200) (5)
- ❑ Industrial Systems Technology (50240) (6)
- ❑ Sustainability Technologies (40370) (7)
- ❑ Other program(s) - please write in the name(s) (8) ____________________
- ❑ I do not supervise any programs (9)

If I do not supervise any prog... Is Selected, Then Skip To End of Survey

Q3 3. How many years have you been employed at this college?

- ❍ 0 to 5 years (1)
- ❍ 6 to 10 years (2)
- ❍ 11 to 15 years (3)
- ❍ 16 to 20 years (4)
- ❍ more than 20 years (5)

Q21 4. Have you been employed somewhere other than this community college?

- ❍ Yes (1)
- ❍ No (2)

If No Is Selected, Then Skip To 5. What is your highest earned academ...

Q25 5. Where have you been employed other than this community college? Please check all that apply.

- ❑ one or more North Carolina Community Colleges (1)
- ❑ community college(s) in a different state (2)
- ❑ another educational institution(s) in North Carolina (3)
- ❑ another educational institution(s) in a different state (4)
- ❑ manufacturing (6)
- ❑ other business(es) or organization(s) - please specify (5) ____________________

Q22 6. Approximately how many years altogether did you work somewhere other than this community college?
- 0-5 years (1)
- 6-10 years (2)
- 11-15 years (3)
- 16-20 years (4)
- more than 20 years (5)

Q5 7. What is your highest earned academic degree?
- high school diploma/GED (1)
- community college Certificate or Diploma (2)
- Associate (2 year) (3)
- Bachelor (4 year) (4)
- Masters (5)
- Doctorate (6)
- other (please describe) (7) ____________________

Q42

Q21 PV is an abbreviation for photovoltaic or photovoltaic systems. PV cells or panels convert sunlight into electricity.

PV skills training consists of a formally organized classroom and laboratory training program over a specified time period.

PV skills training may be the primary subject of a course. PV skills training may also be a topic, project, assignment or section added to another course with a different primary subject.

Q6 8. Approximately when did you first hear about PV skills training?
- ❑ This is the first I have heard of it (1)
- ❑ Within the last year (2)
- ❑ from 1 to less than 2 years (3)
- ❑ from 2 to less than 3 years (4)
- ❑ from 3 to less than 4 years (5)
- ❑ from 4 to less than 5 years (6)
- ❑ more than 5 years (7)
- ❑ Do not recall (8)

If This is the first I have he... Is Selected, Then Skip To 15. How likely is it that your ...

Q7 9. Are you familiar with PV skills training programs offered by any of the following organizations?
- ❑ I am not familiar with any PV skills training programs (1)
- ❑ Continuing education program at a community college (2)
- ❑ Continuing education program at a four year college or university (4)
- ❑ Curriculum program at a community college (3)
- ❑ Curriculum program at a four year college or university (5)
- ❑ National Joint Apprenticeship and Training Committee (NJATC) training program (6)
- ❑ PV standards organization (7)
- ❑ PV equipment manufacturer or distributor (8)
- ❑ Electric utility company (9)
- ❑ Underwriters Laboratory training (10)
- ❑ Private trainer or company (11)
- ❑ other - please specify (12) ____________________

Q8 10. Are you familiar with the following PV skills training program accreditations? Please select all that apply.
- ❑ I am not familiar with PV skills training program accreditations (1)
- ❑ IREC/ISPQ Accreditation for Training Programs (4)
- ❑ IREC/ISPQ Accreditation for Continuing Education Programs (5)
- ❑ Other PV skills training program accreditation(s) (please specify) (6)

Q34 11. Are you familiar with the following PV skills training certifications? Please select all that apply.

- ❑ I am not familiar with PV skills training certifications (1)
- ❑ I know there are certifications, but I don't know the specific certifications (11)
- ❑ NABCEP PV Installer or Technical Sales Certification (2)
- ❑ I am familiar with NABCEP certifications in general, but don't know the certification titles (5)
- ❑ IREC/ISPQ Certification for Independent or Affiliated Master Trainers, and Affiliated or Independent Instructors (7)
- ❑ I am familiar with the IREC/ISPQ standard in general, but don't know the specific certification titles (10)
- ❑ Other PV skills training certification(s) (please specify) (6) ____________________

Q9 12. How or from where have you learned about PV skills training? Please check all that apply.

- ❑ I have not heard from anywhere there is a need (1)
- ❑ There are PV panels or arrays installed on our campus (or one of our campuses) (28)
- ❑ News or media report about PV related activities (3)
- ❑ Article or book (2)
- ❑ Professional society publication (6)
- ❑ NCCCS Super Curriculum Improvement Project (CIP) (21)
- ❑ NCCCS Code Green project (17)
- ❑ Advertising from businesses that use or supply PV products (15)
- ❑ Continuing education course offered at my college (13)
- ❑ Continuing education course at another college or organization (14)
- ❑ North Carolina legislation (4)
- ❑ North Carolina energy report or analysis (5)
- ❑ Do not recall (19)
- ❑ Other (please specify) (20) ____________________

Q41 13. From whom have you learned about PV skills training? Please check all that apply.

- ❑ I have not heard from anyone there is a need (1)
- ❑ Curriculum instructor at my college (8)
- ❑ Curriculum instructor at another college (11)
- ❑ Continuing education instructor at my college (12)
- ❑ Continuing education instructor at another college (7)
- ❑ My supervisor or other administrator at my college such as the President, VP, Dean, etc. (9)
- ❑ An administrator at another college, such as the President, VP, Dean, etc. (10)
- ❑ Speaker at a business or professional society meeting (21)
- ❑ PV distributor or sales person (16)
- ❑ Business or community leader(s) (15)
- ❑ Friend(s) or family (17)
- ❑ Students currently or previously attending my college (18)
- ❑ Other (please specify) (20) ____________________
- ❑ Do not recall (19)

Q30 PV skills training may be the primary subject of a course such as ALT 220 - Photovoltaic Systems Technology.

PV skills training may also be a topic, project, assignment or section added within another course. For example, PV skills may be a special project in an electrical or electronics course (ELC or ELN course codes) or a unit in a building construction course (CST course code).

Q11 14. Has your college ever taught PV skills training within any curriculum courses other than ALT 120 (Renewable Energy Technology), ALT 220 (Photovoltaic Systems Technology) or ALT 221 (Advanced Photovoltaics Design)?

- ❍ yes (1)
- ❍ no (2)
- ❍ I don't know (3)

If no Is Selected, Then Skip To 15. How likely is it that your ...If I don't know Is Selected, Then Skip To 15. How likely is it that your ...

Q12 15. In what academic area(s) and degree level(s) have PV skills been added to the content of existing courses offered at your college? Please select all that apply.

	Associate (1)	Diploma (2)	Certificate (3)
Building Construction Technology (35140) (1)	❑	❑	❑
Construction Management (35190) (2)	❑	❑	❑
Electrical/Electronics Technology (35220) (3)	❑	❑	❑
Electrical Engineering Technology (40180) (4)	❑	❑	❑
Electronics Engineering Technology (40200) (5)	❑	❑	❑
Industrial Systems Technology (50240) (9)	❑	❑	❑
Sustainabilities Technologies (40370) (6)	❑	❑	❑
Other program area(s) - please type the name(s) and code number (if known) (7)	❑	❑	❑

Q10 16. Has your college ever offered ALT 120 (Renewable Energy Technology), ALT 220 (Photovoltaic Systems Technology) or ALT 221 Advanced Photovoltaic Design) curriculum classes?

- ❍ yes (1)
- ❍ no (2)
- ❍ I do not know (3)

Q14 17. How likely is it that your college will offer (or continue to offer) courses where PV skills training is the primary topic or where PV skills training is a topic, assignment or a section in a curriculum course (where PV skills training is not the primary topic) in the future?

- Very Likely (1)
- Somewhat Likely (2)
- Very Unlikely (3)
- Undecided (4)

If Very Unlikely Is Selected, Then Skip To 19. Please add any additional c...

Q15 18. How important are the following factors to your department's or college's decision to add courses where PV skills training is the primary topic or where PV skills training is a topic, assignment or a section in a curriculum course (where PV skills training is not the primary topic) in the future?

	very important (1)	somewhat important (2)	not important (3)
Availability of funding to support equipment needs (1)	❑	❑	❑
Faculty/adjunct willingness to develop courses (2)	❑	❑	❑
Faculty/adjunct willingness to teach courses (3)	❑	❑	❑
Faculty/adjunct technical training on PV skills (4)	❑	❑	❑
Availability of qualified faculty/adjunct instructor (9)	❑	❑	❑
My supervisor or other administrator(s) suggested or required (5)	❑	❑	❑
My personal philosophy of what is important to our students (6)	❑	❑	❑
My personal philosophy of our college responsibility to our community (7)	❑	❑	❑
I want to experiment to determine student interest (8)	❑	❑	❑

Q24 18. (con't) How important are the following factors to your department's or college's decision to add courses where PV skills training is the primary topic or where PV skills training is a topic, assignment or a section in a curriculum course (where PV skills training is not the primary topic) in the future?

	very important (1)	somewhat important (2)	not important (3)
I think it will become a requirement in the NCCCS curriculum standard (1)	❍	❍	❍
College or department advisory board suggested (2)	❍	❍	❍
Other colleges are adding (3)	❍	❍	❍
Potential external funding sources such as grants (4)	❍	❍	❍
Area businesses have asked specifically for it (5)	❍	❍	❍
The technology is exciting to me (6)	❍	❍	❍
Expect students will enroll in course (7)	❍	❍	❍
Course skills will lead to employment for students (8)	❍	❍	❍
Other - please explain (9)	❍	❍	❍

If I think it will become a re... Is Not Empty, Then Skip To 17. Please make any additional ...

Q16 19. Please add any additional comments on your experience (or lack of experience) with photovoltaics skills training.

Q17 20. I would like to receive the final report on the results of this study.

- ❍ yes (1)
- ❍ No (2)

APPENDIX C : NONCREDIT QUESTIONNAIRE

NCCCS PV Skills - Noncredit

Q18 North Carolina Community College System Photovoltaic Skills Training Awareness and Adoption Survey - Continuing Education

The purpose of this survey is to learn if and how your college has considered or adopted photovoltaics skills training into continuing education programs. Continuing Education courses are short-term, noncredit offerings designed to provide education and training opportunities for individuals seeking to gain new and/or upgrade current job-related skills.

The survey asks how and when you first heard (or have not heard) about the need for skills training on photovoltaics skills. Your opinions are equally important if you have not yet considered or have decided not to adopt photovoltaics skills training.

This survey supports the NCCCS Code Green project. CODE GREEN is a North Carolina Community College System (NCCCS) initiative to develop and promote sustainable programs across all 58 NCCCs through educational programs and campus development. Photovoltaics skills training is a part of some sustainable programs.

You were specifically selected as an educational administrator to represent your college for this survey. It is very important for you to respond to the survey so your college will be represented. If you believe you are not the right person to answer these questions from your college please contact Ms. Deborah Porto at dporto@haywood.edu

There are two sections. The survey should take approximately ten minutes to complete. You can return to the survey if you exit.

Thank you very much for your help on this important project. As a token of appreciation for completing the survey, you many elect to receive a copy of the final report from this study.

Q20 To help us learn about our respondents, we would like to ask you a few background questions:

Q1 What is your title?
- ❍ Coordinator (1)
- ❍ Director (2)
- ❍ Dean (3)
- ❍ Vice President (4)
- ❍ Other - please write your title if not any of those listed above (5) ____________________

Q2 Please select the program or programs you directly supervised, or are part of the department/division you supervised in the fall of 2011.
- ❑ Continuing Education (1)
- ❑ Customized Training (2)
- ❑ Workforce Development (6)
- ❑ Economic Development (5)
- ❑ Other program(s) - please write in the name(s) (3) ____________________
- ❑ I do not supervise any programs (4)

If I do not supervise any prog... Is Selected, Then Skip To End of Survey

Q3 How many years have you worked at this college?
- ❍ 0-5 years (1)
- ❍ 6 to 10 years (2)
- ❍ 11 to 15 years (3)
- ❍ 16 to 20 years (4)
- ❍ more than 20 years (5)

Q26 Have you been employed somewhere other than this community college?
- ❍ Yes (1)
- ❍ No (2)

If No Is Selected, Then Skip To 5. What is your highest earned ...

Q24 Where else have you been employed other than this community college? Please check all that apply.
- ❍ one or more North Carolina Community Colleges (1)
- ❍ community college(s) in another state (2)
- ❍ another educational institution in North Carolina (3)
- ❍ another educational institution in a different state (4)
- ❍ manufacturing (6)
- ❍ other business(es) or organization(s) - please specify (5) ____________________

Q27 How many years altogether were you employed somewhere other than this community college?
- ❍ 0-5 years (1)
- ❍ 6-10 years (2)
- ❍ 11-15 years (3)
- ❍ 16-20 years (4)
- ❍ more than 20 years (5)

Q5 What is your highest earned academic degree?
- ❍ high school diploma/GED (1)
- ❍ community college Certificate or Diploma (2)
- ❍ Associate (2 year) (3)
- ❍ Bachelor (4 year) (4)
- ❍ Masters (5)
- ❍ Doctorate (6)
- ❍ other (please describe) (7) ____________________

Q31

Q21 PV is an abbreviation for photovoltaic or photovoltaic systems. PV cells or panels convert sunlight into electricity.

PV skills training consists of a formally organized classroom and/or laboratory training program over a specified period of time.

PV skills training may be the primary subject of a course. PV skills training may also be a topic, project, assignment or section added to another course with a different primary subject.

Q6 Approximately when did you first hear about PV skills training?
- ❍ This is the first I have heard of it. (1)
- ❍ Within the last year (2)
- ❍ from 1 to less than 2 years ago (3)
- ❍ from 2 to less than 3 years ago (4)
- ❍ from 3 to less than 4 years ago (5)
- ❍ from 4 to less than 5 years ago (6)
- ❍ more than 5 years ago (7)
- ❍ Do not recall (8)

If This is the first I have he... Is Selected, Then Skip To 7. Are you familiar with PV ski...

Q7 Are you familiar with PV skills training programs offered by any of the following organizations? Please check all that apply and write the name of the organization if known.
- ❑ I am not familiar with any PV skills training programs (1)
- ❑ Continuing education program at a community college (2)
- ❑ Continuing education program at a four year university (3)
- ❑ Curriculum program at a community college (4)
- ❑ Curriculum program at a four year university (5)
- ❑ National Joint Apprenticeship and Training Committee (NJATC) training program (6)
- ❑ PV standards organization (7)
- ❑ PV equipment manufacturer or distributor (8)
- ❑ Electric utility company (9)
- ❑ Underwriters Laboratory training (10)
- ❑ Private trainer or company (11)
- ❑ other - please specify (12) ____________________

Q8 Are you familiar with the following PV skills training program accreditations? Please select all that apply.

- ❑ I am not familiar with PV skills training program accreditations (1)
- ❑ IREC/ISPQ Accreditation for Training Programs (2)
- ❑ IREC/ISPQ Accreditation for Continuing Education Programs (3)
- ❑ Other PV skills training program accreditation(s) (please specify) (4) ____________________

Q26 Are you familiar with the following PV skills certifications? Please check all that apply.

- ❑ I am not familiar with PV skills training certifications (1)
- ❑ I know there are certifications, but I don't know the specific certifications (11)
- ❑ NABCEP PV Installer or Technical Sales Certification (2)
- ❑ I am familiar with NABCEP certifications in general, but don't know the specific certification titles (4)
- ❑ IREC/ISPQ Certification for Independent/Affiliated Master Trainers or Instructors (5)
- ❑ I am familiar with the IREC/ISPQ certifications in general, but don't know the specific certification titles (9)
- ❑ Other PV skills certification(s) (10) ____________________

Q9 How or from where have you learned about PV skills training? Please check all that apply.

- ❑ I have not heard from anywhere there is a need (1)
- ❑ There are PV panels or arrays installed on our campus (or one of our campuses) (17)
- ❑ News or media report about PV related activities (8)
- ❑ Article or book (2)
- ❑ Professional society publication (6)
- ❑ NCCCS Super Curriculum Improvement Project (CIP) (11)
- ❑ NCCCS Code Green project (16)
- ❑ Advertising from businesses that use or supply PV products (15)
- ❑ North Carolina legislation (4)
- ❑ North Carolina energy report or analysis (5)
- ❑ Do not recall (18)
- ❑ Other (please specify) (19) ____________________

Q27 From whom have you learned about PV skills training? Please check all that apply.
- ❑ I have not heard from anyone there is a need (1)
- ❑ Curriculum instructor at my college (20)
- ❑ Curriculum instructor at another college (33)
- ❑ Continuing education instructor at my college (13)
- ❑ Continuing education instructor at another college (14)
- ❑ My supervisor or other administrator at my college such as the President, VP, Dean, etc. (9)
- ❑ An administrator at another college such as the President, VP, Dean, etc. (10)
- ❑ Speaker at a business or professional society meeting (44)
- ❑ PV distributor or sales person (16)
- ❑ Business or community leader(s) (15)
- ❑ Friend(s) or family (17)
- ❑ Student(s) currently or previously attending my college (12)
- ❑ Other (please specify) (19) ____________________
- ❑ Do not recall (18)

Q10 Has your college ever offered a continuing education course(s) with the primary objective of providing PV skills training?
- ❍ yes (1)
- ❍ no (2)
- ❍ I do not know (3)

If yes Is Selected, Then Skip To What was the name and course number y...If no Is Selected, Then Skip To 11. Has your college ever taugh...If I do not know Is Selected, Then Skip To 11. Has your college ever taugh...

Q21 Do you know the name of the course(s) with the primary objective of providing PV skills training?
- ❍ I do not know the name (1)
- ❍ I know the name(s) (please write name below) (2) ____________________

Q11 Has your college ever added PV concepts into continuing education course(s) (PV skills were discussed or were included in a project or assignment, but PV skills were not the primary objective of the course.)

- yes (1)
- no (2)
- I don't know (3)

If yes Is Selected, Then Skip To 12. What was the name and the course ...If no Is Selected, Then Skip To 14. How likely is it that your ...If I don't know Is Selected, Then Skip To 14. How likely is it that your ...

Q23 What was the name of the course(s) with PV added into continuing education course(s)?
❍ I don't know the name (1)
❍ I know the name (please write below) (2) ____________________

Q14 How likely is it that your college will offer continuing education PV skills training courses or include PV concepts in one or more continuing education courses in the future?
❍ Very Likely (1)
❍ Somewhat Likely (2)
❍ Very Unlikely (3)

Q15 How important are the following factors to your department or college's decision to add PV to courses and/or skills training into continuing education classes?

	very important (1)	somewhat important (2)	not important (3)	I don't know (4)
Availability of funding to support equipment needs (1)	❍	❍	❍	❍
Adjunct instructor or faculty willingness to develop courses (2)	❍	❍	❍	❍
Adjunct instructor or faculty willingness to teach courses (3)	❍	❍	❍	❍
Adjunct or faculty technical training on PV skills (4)	❍	❍	❍	❍
Availability of qualified adjunct instructors (5)	❍	❍	❍	❍
My supervisor or other administrator(s) suggested or required (6)	❍	❍	❍	❍

My personal philosophy of what is important to our students (7)	❍	❍	❍	❍
My personal philosophy of our college responsibility to our community (8)	❍	❍	❍	❍
I want to experiment to determine student interest (9)	❍	❍	❍	❍
10 (10)	❍	❍	❍	❍

Q25 (continued) How important are the following factors to your department or college's decision to add PV to courses and/or skills training into continuing education classes?

	very important (1)	somewhat important (2)	not important (3)	I don't know (4)
I think it will be included in the NCCCS curriculum (credit) standard program of studies (1)	❍	❍	❍	❍
College or department advisory board suggested (2)	❍	❍	❍	❍
Other colleges are adding (3)	❍	❍	❍	❍
Potential external funding sources such as grants (4)	❍	❍	❍	❍
Area businesses have asked specifically for it (5)	❍	❍	❍	❍
The technology is exciting to me (6)	❍	❍	❍	❍
Expect students will enroll in the course (7)	❍	❍	❍	❍
Course skills will lead to employment for students (8)	❍	❍	❍	❍
Other - please explain (9)	❍	❍	❍	❍

Q16 Please add any additional comments on your experience (or lack of experience) with photovoltaics skills training.

Q17 I would like to receive the final report on the results of this study.
- ❍ yes (1)
- ❍ No (2)