Annual Report for Period: 09/2011 - 08/2012
Submitted on: 08/31/2012
Principal Investigator: Tyson, William T.
Award ID: 1104214
Organization: U of South Florida
Submitted By:
Borman, Kathryn - Co-Principal Investigator
Title:
Successful Academic and Employment Pathways in Advanced Technologies

Project Participants

Senior Personnel

Name: Tyson, William
Worked for more than 160 Hours: Yes
Contribution to Project:
Dr. Tyson is the Principal Investigator. He hires and supervises project staff, administers the project, leads the quantitative component, conducts interviews, and is active in both the quantitative and qualitative data analysis.

Name: Borman, Kathryn
Worked for more than 160 Hours: Yes
Contribution to Project:
Dr. Borman is the co-PI. She supervises project staff and is active in both the quantitative and qualitative data analysis.

Name: Boyette, Marie
Worked for more than 160 Hours: Yes
Contribution to Project:
Dr. Boyette is the co-PI and leads the community college component of the project. She networks with community college administrators and teachers in ET programs. She also coordinates the data collection for community colleges.

Post-doc

Graduate Student

Name: Herbert, Marc
Worked for more than 160 Hours: No
Contribution to Project:
Marc Hebert is a doctoral student in the Department of Anthropology. He has conducted interviews and assists with their analysis. He is also a member of the literature review team.

Name: Mehta, Pangri
Worked for more than 160 Hours: No
Contribution to Project:
Pangri Mehta is a graduate student in the Department of Sociology. She has conducted interviews and assists with their analysis. She is also a member of the literature review team.

Name: Zeller, David
Worked for more than 160 Hours: No
Contribution to Project:
David Zeller is a graduate student in the Department of Sociology. He has conducted interviews and assists with their analysis. He is a member of the literature review team.

Name: Behounek, Elaina
Worked for more than 160 Hours: No
Contribution to Project:
Elaina Behounek is adjunct faculty in Sociology. She conducted interviews in the pilot study.

Name: Hilbert, Jeffrey

Worked for more than 160 Hours: No

Contribution to Project:

Jeffrey Hilbert is a graduate student who conducted interviews in the pilot study.

Undergraduate Student

Technician, Programmer

Other Participant

Name: Ponticelli, Christy

Worked for more than 160 Hours: Yes

Contribution to Project:

Dr. Ponticelli is the Qualitative Lead on the grant. She takes the leading role in developing the qualitative instruments and qualitative data analysis. She works closely with Drs. Tyson and Smith supervising graduate students working on the project.

Name: Smith, Chrystal

Worked for more than 160 Hours: Yes

Contribution to Project:

Dr. Smith administers the grant on a daily basis i.e. IRB and budget. She also supervises graduate students. She also works closely with Drs. Tyson and Ponticelli as they develop instruments, conduct field work, and meet with the evalutors.

Name: Heppner, Rebekah

Worked for more than 160 Hours: No

Contribution to Project:

Dr. Rebekah Heppner is an anthropologist with an extensive background in industry. She holds a MBA. She is leading the industry component of the grant. She assists in the development of interview protocols for technology employees and employers. She also conducts these interviews and assists with their analysis.

Name: Hagelin, Katherine

Worked for more than 160 Hours: No

Contribution to Project:

Katherine Hagelin is the transcriptionist hired to transcribed the pilot interviews.

Research Experience for Undergraduates

Organizational Partners

Other Collaborators or Contacts

Our collaborators include Engineering Technology program directors at Polk State College, St. Petersburg College, and State College of Florida.

ICF International led by Thomas Norwood is our external evaluator for
program assessment. A member of his team have also collaborated with us on FLDOE quantiative data requests. The Year 1 external evaluation report is attached to this annual report.

Activities and Findings

Research and Education Activities: (See PDF version submitted by PI at the end of the report)

In light of the growing need for highly trained workers in engineering technology, a collaboration of higher education institutions in Florida is examining the progression of students from high schools into advanced technology programs at community colleges and into the workforce. This collaboration includes researchers from the Departments of Sociology and Anthropology at the University of South Florida and Engineering Technology (ET) program directors at Florida Advanced Technological Center (FLATE) at Hillsborough Community College, Polk State College, St. Petersburg College, and State College of Florida.

This study contributes to a growing body of knowledge on advanced technician education and to the overall mission of the Advanced Technological Education Program by (1) increasing understanding of recruitment and pathways into engineering technology programs; (2) providing information to improve the education of engineering technicians; (3) discovering promising practices that increase the visibility of engineering technology programs at community colleges; and (4) providing information about practices that produce qualified science and engineering technicians to meet workforce demands.

Status of Qualitative Research:

In the first year, Dr. Will Tyson, Principal Investigator, assembled the qualitative research team. Dr. Chris Ponticelli, Associate Professor in Sociology at USF, was hired as the Lead Qualitative Investigator. Other members of the team include Dr. Chrystal Smith, Post-Doctoral Scholar in Anthropology, Dr. Rebekah Hepner, a cultural anthropologist with a MBA and experience in the industry, one anthropology doctoral student, two sociology doctoral students, and one asociology research faculty member.

In addition to constantly communication through email, the qualitative research team along with collaborators at FLATE met five times over the past academic year to discuss project activities. On July 26, 2012, the qualitative research team members visited with ET program directors at the Venice campus of the State College of Florida.

In Year 1, qualitative research team conducted the pilot study at one community college and one ET industry site. We were unable to gain the necessary permission from Hillsborough County Public Schools to conduct the pilot study at a high school with a STEM career academy before the end of Spring 2011.

Qualitative Research Training:

At total of fourteen sociology graduate students were trained in ethical issues and fundamental interview strategies. Each training session lasted approximately two hours. First, students were educated on ethical issues, including security of interview data. This section of the training was consistent with the CITI Human Subjects Foundation course. Second, students were presented with basic interview strategies. Third, each student participated in a mock interview using the pilot interview schedule, followed by an analytic discussion involving all participants. Two sessions were completed. One-on-one training sessions on analytic strategies ensued after interviews were transcribed. An interpretive form of analysis was completed for this pilot study. A computer modeling analysis will be used for future interviews; students will be trained in program use.

Pilot Study

Community College Interviews:

On April 25, 2012, Dr. Tyson, Dr. Ponticelli, and three doctoral students conducted twelve (12) pilot interviews with community college students at St. Petersburg College. The open-ended interview protocal asked students about their pathway into their engineering technology programs. All pilot interviews were conducted before students' classes began and in a courtyard just outside the building where classes took place. Upon completion of the interview students were provided with a $10 payment for their participation. A revised interview schedule is currently being developed and will be submitted to USF IRB for approval.

Industry Interviews:

Dr. Hepner also conducted two pilot industry interviews. The industry protocols were revised, before being tested, to include more in-depth questions and to include some of the same questions being asked of the community college students. These protocols were piloted with one employee and one employer/recruiter, on-site at the business location. The results of analyzing these interviews will be used to revise the protocols which will be used in the main study.

High School Interviews and Focus Groups:

At the end of spring semester 2011, we received permission to conduct pilot focus groups with students and pilot interviews with administrators, counselors, and Career Academy teachers at a high school in Hillsborough County. We have approached the principal at Middleton High School about conducting the research in Fall 2012. We have also submitted an application to get permission to conduct the qualitative research in Sarasota County.

Status of Quantitative Research:

The first task for completing Year 1 quantitative activities was to request the necessary data through data guidelines first established in July 2011. Unfortunately, three different data requests have not been filled to date. For this reason, we have been unable to complete the proposed Year 1 quantitative tasks. The three data requests are included in the material and the process of requesting data and current status of the request are explained below.

In order to meet the guidelines set forth by the Florida Department of Education (FLDOE) PK-20 Education Data Warehouse (EDW) starting in July 2011. This new system is intended to be consistent with areas of the FLDOE Race to the Top grant and to encourage research in areas of interest to FLDOE. The biggest change to this system is that data requests are only accepted on February 1, June 1, and October 1.

After receiving official notice that the grant was awarded in September 2011, we prepared a data request for the October 2011 deadline. This data request proposed to examine two primary areas of the FLDOE 2011-12 Research Agenda: PK-20 and Career and Adult Education. An abbreviated outline of these research areas is below:

5) PK-20
a) Workforce Outcomes
b) Florida's 2+2 Articulation Policies
a) Leaks in the Education Pipeline

6) Career and Adult Education
a) Career and Professional Education Act (CAPE) Academies
b) Industry Certification
c) Adult Education
d) Career and Professional Education Act (CAPE) Academies
e) Industry Certification
f) Adult Education

The purpose of the original October 2011 request was to secure all of the data needed to address the research questions outlined in the original grant proposal. This included data on two primary cohorts:

1) Florida high school students in grades 9-12 beginning with the academic year 2004-05 to present. We will analyze data ninth through twelfth grade high school and post-secondary coursetaking, achievement, and degree attainment among four cohorts of students who graduated from high school and entered into the full-time workforce or post-secondary schooling in 2007-08, 2008-09, 2009-10, 2010-11.)

2) Incoming community college students beginning with the academic year 2007-08 forward to present through Florida higher education and the workforce and backward to 1995 to understand their previous enrollment history and high school background.

The size of this request was in line with previous data requests for other NSF funded projects, although those requests were made several years ago before the current system was in place.

After going months with receiving any word from FLDOE, I e-mailed our contact at FLDOE, Jonathan Blakely, Research Coordinator, Division of Accountability, Research and Measurement. The next day he notified me that the request would have to be trimmed down in order for the request to be filled. He recommended that we ask for the data most necessary to begin the analysis then submit a separate request for additional data and/or variables during another request cycle.

As per Mr. Blakely's suggestions, and with the assistance of our external evaluators at ICF International, we submitted a shorter October 2011 data request for enrollment and employment data for 2007-08 and 2008-09 graduates from Tampa Bay area high schools as opposed to the entire state of Florida. In addition, we submitted a June 2012 request for data on 2007-08 to present community college students only from Tampa Bay area institutions.

On August 10, we received word from Blakely that the revised October 2011 data request was in queue and scheduled to be assigned to a

programmer for fulfillment once resources become available. Unfortunately, he also told us that the majority of June 2012 requests are expected to be declined due to 'resource and capacity issues' at EDW.

Literature Review:

The graduate students on the team conducted the literature review on 1) community colleges and STEM programs, 2) career academies at high schools, and 3) employer industry and ET programs. These literature reviews are combined in one PDF attached to this activities section.

Public Relation Activities:

On December 14th, 2011, USF News interviewed Dr. Tyson about the project's goals and how it would impact STEM education in Florida high schools and community colleges. The article appeared on the main page of the University of South Florida Web site for two week. The article can be found here: http://news.usf.edu/article/templates/?a=4001&z=158

On December 29th, 2011, Dr. Tyson was interviewed about the project by the local newspaper, the Tampa Bay Times. As a result of this interview, Dr. Tyson received emails from over 20 academicians, individuals involved in ET fields, as well as the general public expressing their interest in learning more about the project. The article can be found here:
http://www.tampabay.com/news/education/college/usf-researcher-gets-12-million-for-stem-study/1206637

On January 23rd, 2012, Dr. Tyson appeared on University Beat, WUSF 89.7 FM, a radio program that features the University of South Florida activities. This interview was part 1 in a series on STEM. The interview focused on the importance of this project how it can impact STEM in Florida. The interview can be found here:
http://www.wusf.usf.edu/radio/program/university_beat/episode/2012-01/electric_cars_stem_research_part_1

Dr. Tyson received positive email feedback from members of the public in response to these public relation activities.

Findings:

Pilot Data Findings of Qualitative Research

Community College Interviews:

Based on a small pilot test of community college students enrolled in ET programs, a few descriptive observations can be made. Interviewees were non-traditional age students, and mostly male. Military service and current employer experience played a significant role for several as they decided to enroll in ET programs. They noted specifically that further study in ET would either fill a gap within their current knowledge base or expand and specialize it. In at least one case an interviewee reported that his employer encouraged him to enroll. Some interviewees had been looking for better employment and found job advertisements seeking people with ET experience. In the end, informants found their ET programs through word-of-mouth or computer searches.

Industry Interviews:

The employer that was interviewed was not familiar with the ET program and is currently using a temporary staffing agency for hiring. He does favor Community College graduates; the fact that they have completed an associate's degree is evidence of aptitude and ability to learn. He would like to see better communication skills in new hires.

The employee that we interviewed found his job using the online tool CareerBuilder. It took him nearly a year to find the job and he appears to be under-employed in his current position. He feels that his ET program prepared him for the more technical positions he aspires to, and he plans to go back to school for a bachelors' degree in engineering in the future.

Training and Development:

Graduate students on the Qualitative Research team were trained in ethical issues, fundamental interview techniques, and security of interview data. These students also participated in a mock interview using the pilot interview. The students used these acquired skills to gain experience conducting interviews in the field.

Outreach Activities:

Journal Publications

Books or Other One-time Publications

Web/Internet Site

URL(s):
http://anthropology.usf.edu/aarea/research_projects/ate/
Description:
This is a temporary Web site that provides information about our grant and our activities.

Other Specific Products

Contributions

Contributions within Discipline:

Contributions to Other Disciplines:

Contributions to Human Resource Development:

Contributions to Resources for Research and Education:

Contributions Beyond Science and Engineering:

Conference Proceedings

Special Requirements

Special reporting requirements: None
Change in Objectives or Scope: None
Animal, Human Subjects, Biohazards: None

Categories for which nothing is reported:

Organizational Partners
Activities and Findings: Any Outreach Activities
Any Journal
Any Book
Any Product
Contributions: To Any within Discipline
Contributions: To Any Other Disciplines
Contributions: To Any Human Resource Development
Contributions: To Any Resources for Research and Education
Contributions: To Any Beyond Science and Engineering
Any Conference

Annual External Evaluation Report

PathTech: Successful Academic and Employment Pathways in Advanced Technologies

NSF Award #1104214

August 31, 2012

Submitted by:
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Table of Contents

1. Overview of PathTech and the External Evaluation

1.1 About the PathTech Project

The Successful Academic and Employment Pathways in Advanced Technologies (PathTech) project is funded through a grant from the National Science Foundation (NSF) Directorate for Education and Human Resources (DEHR) under the Advanced Technological Education (ATE) program (NSF Award #1104214). The NSF ATE program promotes the improvement of education, particularly at two-year colleges, for science and engineering technicians entering into high-technology fields. The ATE program supports different types of activities, including the development of curriculum, educator professional development, career pathways, articulation between two-year and four-year programs for potential educators, and research to add to the understanding of various aspects of technician education.

PathTech is a research study designed to examine the progression of students from high school into advanced technology programs, specifically engineering technology (ET), at community colleges and into the workforce. This study will be conducted over four years between September 1, 2011 and August 31, 2015. Grant funds for this project period total $1,196,790.

The NSF ATE grant for the PathTech project was awarded to the University of South Florida (USF), which established a collaboration of higher education institutions in Florida, including researchers from the Departments of Sociology and Anthropology at USF, the Florida Advanced Technological Center (FLATE) at Hillsborough Community College (HCC), Polk State College, St. Petersburg College, and State College of Florida. Dr. Will Tyson (USF) is the principal investigator, and Dr. Kathryn Borman (USF) and Dr. Marie Boyette (HCC) are serving as co-principal investigators. In Year 1 of the grant, the project leaders expanded the research team to include university students and other research staff to contribute to the PathTech project.

1.1.1 PathTech Research Design and Methodology

The PathTech project contributes to a growing body of knowledge on advanced technician education and to the overall mission of the NSF ATE program by:

- increasing understanding of recruitment and pathways into engineering technology programs,
- providing information to improve the education of engineering technicians,
- discovering promising practices that increase the visibility of ET programs at community colleges, and
- providing information about practices that produce qualified science and engineering technicians to meet workforce demands.

RESEARCH QUESTIONS

The purpose of the research study is to answer two research questions (with subquestions):

1. Who enrolls in ET community college programs out of high school?
    a. How are student demographic and academic characteristics related to ET enrollment?
    b. How do students learn about ET programs (i.e., outreach)?
    c. How can the pathway from high school into ET programs be improved?

2. How do ET students benefit from enrolling (in degree programs) and earning degrees through these programs?
    a. What are the most critical steps in ET degree attainment from enrollment through gatekeeper courses and to the degree?
    b. How do these students become ET graduates?
    c. How do ET students differ from comparable students in their degree and employment outcomes?

METHODOLOGY

PathTech is a mixed-method study that is employing both descriptive statistics and empirical analysis of verifiable quantitative data from state databases along with ethnographic (qualitative) methods. Quantitative analyses examine statewide trends in career academy participation and engineering technology enrollment. Quantitative data will come from the Florida Department of Education (FLDOE) PK-20 Education Data Warehouse (EDW) and from site visits to construct several indicators of high school preparation that predict enrollment into engineering technology programs. The research team will analyze retrospective data from students during Grades 9-12 to measure high school and post-secondary coursetaking, achievement, and degree attainment. Four cohorts of students who graduated from high school and entered into the full-time workforce or post-secondary schooling in 2007-08, 2008-09, 2009-10, 2010-11 will be tracked.

Qualitative analyses focus on four engineering technology programs housed at community college campus in the Tampa Bay region of Florida, as well as feeder high schools and local industry. Site visits will take place in this region, which contains a concentration of high school STEM career academies, STEM industry, and community colleges that offer advanced technology associates degrees.

1.1.2 PathTech Project Timeline

In Year 1 of the PathTech project, the research team was to conduct these activities:

- Create project brochure highlighting goals and purpose of study for stakeholders
- Conduct pilot site visits to pilot test instruments in one high school, community college, and industry
- Request additional Florida Department of Education (FLDOE) data updates
- Carry out data preparation, descriptive analysis of current FLDOE data
- Conduct propensity score analysis to create samples of students with equal propensity of being in a STEM-themed career academy and propensity score analysis at the school level to create pairs of schools with equal propensity of having a STEM-themed career academy in using Cohorts 1 and 2
- Conduct a literature review on technician education
- Write one paper for dissemination at a relevant conference and/or journal article for a peer reviewed journal

1.2 About the External Evaluation

The external evaluation of PathTech is being conducted by ICF International, led by Thomas Horwood as lead evaluator and supported by Dr. Teresa Duncan and Dr. Katerina Passa. The

external evaluation is intended to complement and support the efforts of the PathTech research team. The approach to external evaluation involves: (1) monitoring the progress of the project; (2) providing objective reviews of project instruments, protocols, analysis plans, and reports; and (3) serving as an external resource for technical advice.

This report serves as the first in a series of four annual evaluation reports and covers the first year of the implementation of the PathTech project. Data was collected for this report through conversations with the PathTech project team and through review of project documents (e.g., grant application, research instruments, research protocols, reports.

2. External Evaluation Findings – Year 1

This annual external evaluation report #1 assesses the PathTech project team's progress according to the workplan during the first year of the grant. The Year 1 project period was September 1, 2011 to August 31, 2012. Exhibit 1 shows the activities completed, status, and notes about each PathTech task for Year 1 of the grant project period. Of the seven Year 1 tasks, one involves marketing the PathTech project, one is for qualitative data collection protocols, three are for quantitative data collection and analysis, one involves literature reviews, and one involves dissemination.

Exhibit 1: Status of PathTech Tasks for Year 1 (September 1, 2011-August 31, 2012)

Year 1 Task	Activities Completed – Year 1	Status at End of Year 1	Notes
1. Create project brochure highlighting goals and purpose of study for stakeholders	▪ PathTech web site landing page was developed and includes a brief project overview	In Progress	▪ Continuing to work on brochure, building out the web site, and business cards for PathTech staff
2. Conduct pilot site visits to pilot test instruments in one high school, community college, and industry	▪ Conducted the pilot site visits at one community college and one ET company ▪ Conducted 12 pilot interviews with community college students at St. Petersburg College on April 25, 2012 ▪ Conducted pilot interviews with one employee and one employer/recruiter on-site at the ET company location ▪ Trained 14 student interviewers in ethical issues and fundamental interview strategies ▪ Conducted one-on-one training sessions on analytic strategies after interviews were transcribed	In Progress	▪ Unable to gain the necessary permission to access the high school by the end of the academic year 2011–2012; will revisit in Year 2
3. Request additional Florida Department of Education (FLDOE) data updates	▪ Submitted data requests to FLDOE	Delayed	▪ Three data requests have not been filled by FLDOE due to lack of data staff availability
4. Carry out data preparation, descriptive analysis of current	▪ See Task 3	Delayed	▪ See Task 3

Year 1 Task	Activities Completed – Year 1	Status at End of Year 1	Notes
FLDOE data			
5. Conduct propensity score analysis to create samples of students with equal propensity of being in a STEM-themed career academy and propensity score analysis at the school level to create pairs of schools with equal propensity of having a STEM-themed career academy in using Cohorts 1 and 2	▪ Created analysis plans based on known variables expected to be collected ▪ See Task 3	Delayed	▪ See Task 3
6. Conduct a literature review on technician education	▪ Conducted a literature search to collect articles and other materials in three topic area: high schools, community colleges, and industry ▪ Wrote three literature reviews, which will be updated on a regular basis throughout the grant project period to continually inform the project	Complete	▪ PathTech: Review of the Literature about Community College Graduates and Employers by Marc Hébert ▪ Path Tech: Literature Review on Community Colleges and STEM Programs by Margaret Cooper ▪ PathTech: High School and Career Academies Literature Review by Pangri Mehta and David Zeller
7. Write one paper for dissemination at a relevant conference and/or journal article for a peer reviewed journal	▪ No action	Not Started	▪ Insufficient data (see Task 3) to develop publications/ presentations

Of the seven Year 1 tasks, one is complete, two are in progress, three are delayed, and one was not started. The marketing task is in progress and will continue to be finalized in Year 2. The task to develop and pilot the qualitative data collection protocols has shown the most progress, but the status is in progress due to the inability to gain entry to the high school by the end of the 2011-2012 academic year, which will happen in Year 2. The three quantitative data collection and analysis tasks were delayed because FLDOE has not yet provided access to the needed student data. The research team will continue in Year 2 to request this data. The status of the literature review task is listed as complete for Year 1, but the literature reviews will continue to be updated throughout the course of the grant period to inform all tasks. The dissemination task has not started due to insufficient data.

3. Conclusions

Year 1 of the PathTech project was mostly about project startup, including the establishment of the larger research team and ongoing planning by the project leaders. While seven tasks were planned for Year 1, only one was completed. The research team collected literature and wrote up three literature reviews on focused topics for the literature review task (Task 6), which will be updated throughout the course of the project. While still in progress, the research team successfully completed several activities for the ethnographic (qualitative) research task (Task 2), which is a cornerstone of the PathTech study. Task 1, the marketing task, is in progress since the brochure still needs to be finalized in Year 2; however, a project web site has been

started to inform the public and project stakeholders about the project. Three of the tasks (Tasks 3-5) were delayed since FLDOE was not able to provide all of the needed data as requested by the PathTech research team. However, the research team did start to plan for how to analyze the data once all datasets are received (Task 5). Lastly, Task 7, the dissemination task, has not been started due mostly to having insufficient data.

4. Next Steps in the External Evaluation

Evaluation activities over the next three years of the NSF grant period will include: (1) ongoing monitoring of the progress of the project against project timelines; (2) objective review of data collection protocols, site visit criteria, and quality of the propensity score matching results; (3) evaluation of the interpretability of course trajectories between the cohorts (years 2 and 3); and (4) review of the replicability of the analyses conducted; provide recommendations for future directions.

In addition, the evaluation team will serve as external resources for technical advice, and will provide commentaries and written reviews of the project's various activities. In addition, he will maintain regular, monthly contact with Dr. Tyson and his team via teleconferences and email, bringing in other members of the external evaluation team as needed. He will prepare monthly monitoring memos, in which the research team's progress towards project milestones is assessed and suggestions for addressing challenges are provided.

Each year, the external evaluation team will prepare an annual evaluation report summarizing evaluation activities and findings. Each annual evaluation report will build off of each other starting with this report, and will be submitted to NSF as part of the annual reporting requirements, as evidence of the quality of the project's quality assurance procedures.

PathTech: Review of the Literature about Community College Graduates and Employers

by Marc Hébert – August 20, 2012 (last updated)

OVERVIEW

56 studies were reviewed. A spreadsheet available in the shared Google Drive for PathTech lists each study according to (1) the type of publication (e.g., report, scholarly journal, news source, etc.), (2) the questions or hypotheses driving the research and the methods used, (3) assumptions about the research as well as (4) the pertinent findings and conclusions. These data were then cut and pasted into the bibliographic software EndNote; where the accompanying articles are attached. The Google spreadsheet was imported into text analysis software, unearthing 23 unique topics or themes across the literature. Each study in this review may contain multiple themes, but each unique theme was counted only once per study. The themes arose inductively except for four deductive themes dealing with similar demographic populations of PathTech research, namely underrepresented populations in STEM education and careers. The deductive themes were grouped by (1) race and ethnicity, (2) socioeconomic class, (3) gender as well as (4) disability and impairment.

This document is organized as follows:

HOW THE LITERATURE REVIEW INFORMS THE PATHTECH RESEARCH

The literature review informs the PathTech research in at least two ways. The first is by revising the interview protocols with graduates of community colleges and employers. The second is reflecting on how amending the interview protocols might shape the intended scope of the project and anticipated outcomes. The recommendations offered here are based on my analysis of the interview questions that were shared with Will and Chris in a June 2012 document titled "Marc Hebert, Suggestions to Improve Interview Questions, 6.4.12." The following recommendations are intended to complement trends in the literature and shore-up gaps in it as well.

Questions for and about Graduates of Community Colleges

Gaps in the Literature

- Inquire about their quality of life now that they are working: Are they satisfied with their education? How do they define "satisfied?" Where do they see themselves professionally five years from now? Does this vision entail further education? If so, then what type and how do they plan to acquire it (e.g., online vs. in-person education, public or private institution, 2-year or 4-year degree institution)? Do they feel their community college education created a glass ceiling, limiting their professional development?
- For all the research on STEM, no study reportedly asked graduates about the role of technology in their lives, society or in the future. Technology as a professional instrument/tool is divorced from technology as a means to socialize or live meaningfully.

- Little research inquired about graduates' social network (e.g., family and friends) and its role in influencing graduates' decisions and life choices as related to STEM education. The focus on the individual divorced from society and the culture(s) to which s/he belongs implies personal decisions and experiences happen in isolation from others and one's environment.

Complement the Existing Literature

- How do graduates describe their socialization process in their working environment?
- Were they employed while studying? How did this impact both their ability to be hired and acculturate to their current working environment?
- Some researchers attempted to create models to explain successes or challenges in education-employment pathways, to what degree will PathTech do the same, if at all?

Questions for and about Employers

Gaps in the Literature

- What has influenced the way hiring managers perceive the employability of community college graduates (i.e., the media, cultural stereotypes about these graduates, on the job performance, etc.)?
- What is the highest level that a community college degree will likely allow an employee to achieve in the company? Why?
- How many community college graduates are in management positions within the company, where are they exactly in management, and did they achieve these positions without formal education beyond the community college degree?

Complement the Existing Literature

- Describe your company's relationship with local community colleges (e.g., does anyone sit on the board, present at job fairs, give guest lectures, teach part-time, advise on curriculum, help create a certificate or degree program, invite work-study or apprenticeships)?
- Does your company collaborate or receive any support from federal, state and local government for partnering with community colleges? If so, then how? If not, then would you like to learn more about such opportunities?
- If "hard skills" mean "technical skills and knowledge" and the term "soft skills" means the ability to problem solve, think comprehensively, communicate clearly and socialize well with others, then how would you describe the hard and soft skills of your community college graduates?
- How do the hard and soft skills of community college graduates compare with those with a Bachelor's degree?

KEY FINDINGS – THEMATICALLY

The most dominant theme to emerge in the literature is that employers are often involved in shaping community colleges' curriculum. 23 separate studies in the literature dealt with this theme. Employer involvement assumes different forms of partnerships "between local employers and the community college such as industry advisory boards, guest speakers, and job fairs " (Hirschy, et al. 2011, p. 312) as well as "learn and earn" models where employers design certificate or degree programs specifically for their employment needs (Corporate Voices 2012a, b).

The idea of employers shaping community colleges' curriculum corresponded with several other themes in the literature review. For example, government funding for public-private partnerships is an overlapping theme and involved six separate studies examining federal, state or city level support for the public-private partnerships. There is USDA funding for community colleges to train low-income individuals (Gragg and Pawling 2012). The employment agency in the city of Charlotte and the North Carolina state government "created and launched a dynamic website to help potential employees [graduating from

community colleges to] understand and apply for opportunities at Siemens" (Vickers-Koch 2011, p. 25). Government funding also takes the form of tax incentives that motivate businesses to collaboration with community colleges (Corporate Voices 2011).

Gender, race or ethnicity and socioeconomic class favored prominently in the literature. 13 studies involved some aspect of gender; typically dealing with differences between men and women. One example is, "attendance at a two-year college, even for those students who expect to complete a bachelor's degree […lowers] the probability of completing a bachelor's degree […] by approximately 23% points for men and 25% points for women" (Reynolds 2012, p. 346). For women who did complete their degree, however, "the earnings effect of an associate degree for women is more than twice that of men" (Marcotte 2010, p. 49). One of the most reflective articles that blended gender and race and ethnicity involved a mother-daughter co-authored paper. Each is a scientist and together they "connect the past and the present regarding the pathways used by minority women entering STEM, their patterns of advancement, and shifting paradigms on how best to support women of color in these fields" (Malcom and Malcom 2011, p. 162).

15 studies included some dimension of race and ethnicity. For example, income disparity between "community college and 4-year college entrants remained small for most groups, with the exception of Black and Hispanic males" (Levey 2010, p. 3). Graduates with certificates from community colleges were also analyzed demographically, and differences in their earning potential were compared with other groups along racial and gender lines (Carnevale, et al. 2012). One large study examining "the role community colleges play [in Florida] in enhancing the upward economic mobility of their students" used race and ethnicity for analysis (Furchtgott-Roth, et al. 2009, p. 2).

Interestingly, 13 studies included class, though the word itself was not often invoked. These studies referred instead to "economic mobility" and "future earnings potential." One study explicit about class argued about the existence of a "distinctly disadvantaged underclass at cumulative risk of dropping out of high school and college due to their structural positioning within our educational institutions [leaving them neither oriented towards employment in industry nor continuing with higher education]" (Deil-Amen and DeLuca 2010, p. 43). The theme identified as "Benefits of a Community College or High School Technical Degree" overlaps with the theme of socioeconomic class because the former them mostly identified financial gain as the primary benefit of an education compared with other quality of life factors.

People with disabilities and impairments are another prominent group when considering underrepresented populations in STEM education and careers, however, only two studies considered this group of people in their discussions (Deil-Amen and DeLuca 2010; Flexer, et al. 2011).

Finally, the constraints of community colleges were another important theme. "The academic and corporate agendas for STEM education that enable students to advance from two- to four-year degrees in these fields and the need to offer programs that propel students toward specific careers in STEM are not always well aligned" (NRC 2012, p. 8). Budget cutbacks of public two-year institutions were another challenge.

KEY FINDINGS – METHODOLOGICALLY

The methods used in the literature, shown on page four, identify interviews as the third most common data gathering technique after archival research and analysis of preexisting quantitative datasets. The interviews in the reviewed literature, however, were largely with employers and focused on a blend of technical skills assessing community college graduates as well as less-technical skills, including communication, general problem solving and overall ability to acculturate to the employer's working

environment (Van Noy and Jacobs 2012). Other interviews examined employers' future technological needs (BATEC 2007).

Interviews were used for diverse purposes when speaking to students or those who graduated from technical high schools and community colleges. Some studies relied on these interviews to create a systems or ecological approach for understanding more holistically the pathway from technical high school or community college to employment (BHEF 2010; Karandjeff and Schiorring 2011). Only one study explicitly considered the socialization of community college graduates into the workforce from the graduates' perspective (Thomes 2012). The same author of this research was the only one to spend time in a community college classroom, observing students learn and interact with each other and the professor.

Will Responded to the Findings from this Report on July 23, 2012 in an Email to Marc. His insights are included below the boldface type of each paragraph:

"A few things stood out for me that we need to make sure we focus on throughout the project.

The CC Glass Ceiling:

Do they feel their community college education created a glass ceiling, limiting their professional development?

--This is an angle that isn't covered in much of the discussion of CC STEM jobs. The assumption is that these jobs are good for a certain subset of the population who isn't expected to do much better. But we want to know if they are "good jobs" with the opportunity for advancement. I especially liked the employer questions about how high in the business someone can get with just a CC degree. We need to broaden our scope beyond the transition into the full-time workforce and into the long-term outcomes of CC degrees.

Models of CC STEM Pathways:

- **Some researchers attempted to create models to explain successes or challenges in education-employment pathways, to what degree will PathTech do the same, if at all?**

We need to review these models and figure out how we can improve upon these models with the qualitative and quantitative capacity of this study. Such models could also justify continued research on long-term outcomes as discussed above.

Private-Public Partnerships:

The most dominant theme to emerge in the literature is that employers are often involved in shaping community colleges' curriculum.

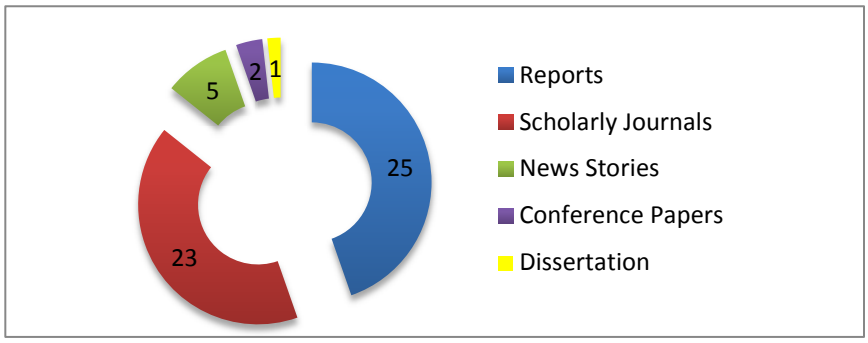
So far we don't have anything addressing this from the CC. We should ask ET program faculty and administrators how they benefit from public-private partnerships and federal, state, local funding for such partnerships. We should do the same with career academies and HS administrators as well. I'm skeptical that the institutions are benefitting from the public money as much as the private sector is.

Methodology:

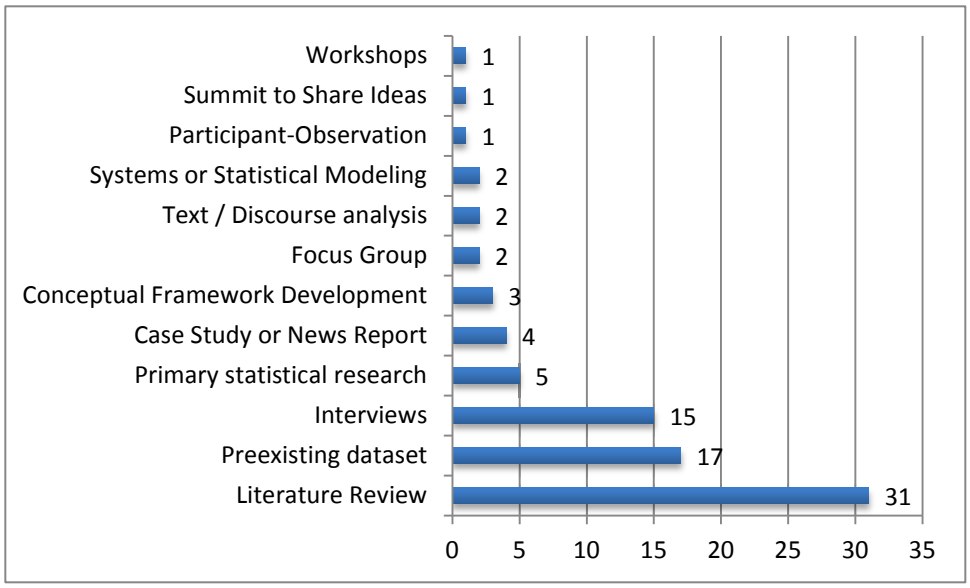
The methods used in the literature, shown on page four, identify interviews as the third most common data gathering technique after archival research and analysis of preexisting quantitative datasets.

This is more evidence that using narratives would allow this study to stand out and for the findings to have a broader impact. We can set out to tell effective stories of the lives of people on these pathways and establish models based on these findings." [end of email]

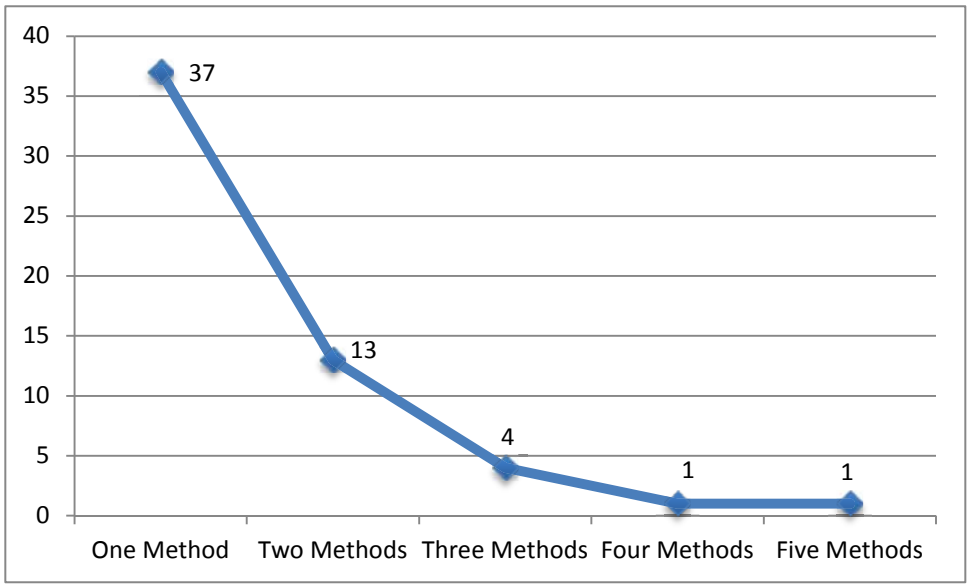
Composition of the 56 References Included in the Literature Review



12 Methods Used across the Reviewed Literature



Number of Unique Data Gathering Methods to Compare Findings



23 Themes That Emerged from The Literature Review *(a study may contain multiple themes)*

No.	Theme	Number of Separate Studies That Explored This Theme	Definition of Theme	Overlapping Themes by Color
1	Employers Shape Curriculum	23	Employer involvement ranged from sitting on the boards of community colleges and hosting job fairs and presentations about careers to designing the certificate or degree program with the community college.	EMPLOYERS SHAPE CURRICULUM
2	Race & Ethnicity	15	Used to compare demographic groups, especially for statistical purposes.	UNDERREPRESENTED POPULATION
3	Socioeconomic Class	13	Rarely called "class" explicitly. It most often appeared to demonstrate how a community college education could lead to economic mobility or more income.	UNDERREP. POPULATION / ECONOMIC MOBILITY
4	Gender	13	Used to compare demographic groups, especially for statistical purposes.	UNDERREPRESENTED POPULATION

5	Benefits of a Community College or High School Technical Degree	10	Eight of the studies equated "benefits" with increased income and two of the studies included such things as improved access to health care and lower incarceration rates.	**ECONOMIC MOBILITY**
6	Government Support for Community College-Industry Partnership or Job Training	6	Governments at the federal, state and municipal level provide different kinds of assistance to companies to collaborate with community colleges. For example, creating websites to help community college graduates find jobs with specific companies or giving businesses tax breaks.	**EMPLOYERS SHAPE CURRICULUM**
7	In-School Work Experience	5	Working and studying can benefit the preparation of students for future employment, specifically hands on training and the employment socialization process. Apprenticeships were singled out as particularly helpful in this aim. There are also negative effects from working while studying; including lowered academic achievement or grades.	**IN-SCHOOL WORK EXPERIENCE**
8	Community Colleges Should Assess Labor Market Demands	5	Improving the employability of community college students by offering more relevant courses. Following labor market demands, such as job aggregating websites, may strengthen this aim.	**EMPLOYERS SHAPE CURRICULUM**
No.	**Theme**	**Number of Separate Studies That Explored This Theme**	**Definition of Theme**	**Overlapping Themes by Color**
9	2-year Degrees Can Harm Future Earnings, Educational Attainment & Employer Perceptions	4	Three types of "harm" are included: (1) diminished future earnings after receiving an associate's degree and then obtaining a bachelor's, master's or PhD. (2) Likelihood of acquiring a 4-year degree after a 2-year degree. (3) Employers do not perceive a 2-year degree holder's character as equal with a 4-year degree	n/a

			holder, particular in terms of "academic ability, initiative, or skill".		
10	High Demand for Jobs that Community Colleges Can Supply	4	Community colleges are singled out as educational institutions to address labor market shortages.	**EMPLOYERS SHAPE CURRICULUM**	
11	Employers Need Community College Graduates Already Socialized into the Labor Market	4	Employers less often critique the technical skills of community college graduates than their communication skills or broader knowledge to discern problems and articulate solutions. Strategies are offered to improve worker integration into the marketplace.	**EMPLOYERS SHAPE CURRICULUM**	**IN-SCHOOL WORK EXPERIENCE**
12	High School Technical Education	4	Recommendations for providing high school students with better career mentoring and technical education is offered, including more interactive STEM-employment presentations and improved training for guidance counselors. One study also focuses on the obstacles for students with 2-year technical degrees to transfer successfully to a 4-year degree institution.	**EMPLOYERS SHAPE CURRICULUM**	
13	Florida Community Colleges	3	Studies that focused or included Florida community colleges.	n/a	
14	Community Colleges & Regional Industries	2	While community colleges may be explicit about training students to compete in a "global marketplace" graduates of these programs often remain local and provide labor for local industries.	**EMPLOYERS SHAPE CURRICULUM**	
15	Job Training vs. 4-Year Degree Preparation	2	Community colleges experience tension between training students for jobs and preparing them to transfer to a 4-year degree granting institution.	**CONSTRAINTS OF COMMUNITY COLLEGES**	

No.	Theme	Number of Separate Studies That Explored This Theme	Definition of Theme	Overlapping Themes by Color
16	Disability/Impairment	1	Used to compare demographic groups.	**UNDERREPRESENTED POPULATION**
17	Community Colleges Can Reduce the Time and Costs on Students to Achieve Degree Completion	1	Recommendations for "degree productivity" are offered.	n/a
18	Budget Cuts Strain Community Colleges	1	They are challenged by how best to allocate funding and generate revenue.	**CONSTRAINTS OF COMMUNITY COLLEGES**
19	Earnings from Certificates Compared with Associate Degrees	1	Public and private two-year degree granting institutions are increasing producing certificate programs that can provide jobs equal or greater in pay than an associate's degree.	n/a
20	Evaluating NSF-funded ATE Centers	1	Advanced Technological Education (ATE) programs and the centers that operate them need standardized metrics for program effectiveness.	n/a
21	Evaluating the Vocational and Technical Education System	1	This study examines the "system put in place by all states to meet the accountability requirements under the Carl D. Perkins Act" that encouraged U.S. vocational and technical education.	n/a
22	Community College Mission Statements	1	The mission statements of 421 community colleges are examined for ideological orientations.	n/a
23	Online vs. In-person Education	1	The merits of online courses at community college are compared with in-person education.	n/a

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PATHTECH High School and Career Academies Literature Review
by Pangri Mehta and David Zeller

Research in career and technical education (CTE) that explores student pathways from high school through degree completion and employment tends to focus primarily on post-secondary outcomes. A significant and growing body of research on high schools and career academies[1], however, has begun to offer additional insights into CTE pathways. The sampling of reports and peer-reviewed research reviewed below addresses the history and current structure of career academies, as well as issues of outreach (how students learn about these programs), enrollment (including demographic and academic characteristics of students), and evaluation (how CTE pathways might be improved with respect to career academies).

According to the authors of one comprehensive report, "The number of career academies has been expanding rapidly, in part because academies have been found to be effective, and in part because they embody ideas promoted by several major high school reform movements" (Stern, Dayton, and Raby, 2000, p. 1). The National Career Academy Coalition website states that career academies "have expanded to more than 1,500 high schools nationwide" since their inception in 1969 (NCAC, 2012b). Career academies were initially conceived in Philadelphia as dropout prevention programs (Kemple & Rock, 1996; Kemple & Snipes, 2000; NCAC, 2012b) but they have undergone considerable reforms over the past 40 years. The unique makeup of contemporary career academies is designed in part to address student perceptions of alienation and disconnectedness from the wider high school community. Their beginnings as dropout prevention programs can still be seen in the emphasis placed on the importance of the peer group support system. The goals of career academies have expanded beyond addressing the needs of "at-risk" youths, however, and today they feature preparatory curricula both for students who plan to start working directly following high school as well as for those who are interested in college. Career academy curricula as well as employer partnerships are explicitly designed to connect the classroom to the "real world" of work by clarifying and streamlining the school-to-work transition (Kemple & Rock, 1996; Kemple & Snipes, 2000; Stern et al., 2000).

High schools and career academies often serve as "trailheads" that mark the start of the CTE pathway for students. For example, high school guidance counselors are a common source of advice during what is commonly referred to as the "school-to-work transition." While high schools are a familiar enough setting, career academies are unique and relatively novel in their contemporary form. These "schools-within-schools" serve as incubators for science, technology, engineering, and mathematics (STEM) careers as well as a wide variety of other technical fields

[1] "Several leading organizations of career academies have agreed on a common standard for academies, and use the following parameters when describing a career academy:

- a small learning community, comprised of a group of students within the larger high school, who take classes together for at least two years, and are taught by a team of teachers from different disciplines;
- a college preparatory curriculum with a career theme, enabling students to see relationships among academic subjects, and their application to a broad field of work; and
- partnerships with employers, the community, and local colleges, bring resources from outside the high school to improve student motivation and achievement" (NCAC, 2012a).

such as multimedia design, marketing, and the culinary arts, to name a few[2]. Some high schools, seeking to improve educational outcomes, have implemented the career academy model schoolwide by enrolling all of their students in career academies (Stern, Dayton, Lenz, & Tidyman, 2001).

Qualitative research has also provided some insight into how students learn about CTE programs in the first place. Haun-Frank's (2011) study of narrative identity followed fourteen African-American students, mapping the pathways they followed as they pursued education and careers in science. The author found that the students' stories frequently drew on talk about "everyday spaces" like schools, neighborhoods, and churches. Their experiences in these sites influenced and encouraged their later educational and career ambitions.

Career academies tend to attract large numbers of applicants from diverse demographic and educational backgrounds (Kemple & Rock, 1996). These differences among students allow researchers to determine which kinds of students benefit most from the career academy model. For example, Maxwell and Rubin (2002) compared career academy participants with non-participants with respect to post-secondary outcomes using data from both a single, "inner city"-style school district with data from a national sample of school districts. They found that career academies helped some students, noting that they tended to improve outcomes for "at-risk" students, especially in the single district that they analyzed. However, they argue that since these programs cost more money than traditional (academic) programs, and since they may only be helpful to districts with a large proportion of students who are "at-risk," ultimately it may not be cost effective to implement a career academy program nationwide. Their findings could be characterized as providing moderate support for the effectiveness of high school career academies.

Despite repeated reforms in the United States educational system, some education research suggests that additional reforms are required to combat stagnation. Stern's (2009) advice echoes many of the previous concerns of school-to-work advocates, while incorporating an emphasis on accountability that has become the hallmark of more recent education reforms like "No Child Left Behind." He suggests that 1) schools should pave the way to both college and careers, 2) education funding should be tied to learning, graduation, and career outcomes, 3) other adults like advisors, mentors, and counselors can help guide students and assist teachers, and 4) internet-based education should be expanded to provide students with options that are less inhibited by geography (Stern, 2009).

Brand (2008) outlines the elements of current CTE programs and provides an extensive accounting of these programs' shortcomings. Noting that CTE programs are negatively perceived, Brand goes on to argue that 1) student success is too narrowly defined, 2) there is generally a lack of inclusion of CTE educator perspectives on educational policy, 3) there is not enough applied curriculum, 4) there are not enough different kinds of assessment, 5) connections with postsecondary education are tenuous, 6) guidance counselors and academic advisors are often un- or under-informed, 6) CTE educator support, training, credentialing, and certification

[2] For a descriptive overview of the curriculum, structure, and characteristics of high schools and student-participants in a sample of Florida's career academies, see the Regional Educational Laboratory's (2011) report listed in the references.

needs improvement, and finally, that 7) there is a lack of longitudinal data on outcomes.

Researchers' findings are not always so grim with respect to CTE programs, however. Bragg and Ruud (2007) tested the impact of two CTE programs in terms of academic performance, career pathways, and the transition to college and careers. They followed students from 52 different high schools and compared participants in one of two programs that would prepare them for a career either in information technology (IT) or as an emergency medical technician (EMT) to those students who did not participate in CTE programs. Their findings (which generally showed equal or better outcomes for CTE participants vs. non-participants) seem to strongly support the aims of the Carl D. Perkins legislation ("Perkins VI") since it "calls for an expansion of career-related 'programs of study'" (Bragg & Ruud, 2007, p. 4).

In the more than 40 years since career academies were initially created, research has tended to support the idea that school-to-work transition programs are beneficial, especially for those students who have had difficult or otherwise unsatisfying experiences in traditional academic settings. Longitudinal documentation of CTE students' experiences, ideally from pre- or early high school through eventual employment would further clarify the promising and problematic elements of CTE programs and the various pathways that students follow in pursuit of their educational and career goals.

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Path Tech Literature Review on Community Colleges and STEM programs
By Margaret Cooper

For this literature review, 76 articles and reports were analyzed on the topics of STEM education, in particular, and technical education programs, in general, within community college context. In this review, the reader will be able to gain an understanding of what work has already been conducted in this field. In addition, I will also provide an observation regarding gaps in the literature and needs for future research. Overall, articles and reports fell within the following categories:

1) Public or social policy (2 articles)
2) Partnerships between community colleges and industry (7 articles)
3) Overall role and value of community colleges (2 articles)
4) Overview of research on STEM and historical development of technical education (3 articles)
5) Promotion of STEM and technological literacy (5 articles)
6) Issues related to teachers (5 articles)
7) Curriculum development and pedagogical concerns (23 articles)
8) Student' characteristics, success and transitions (29 articles)

In general, most all authors begin with the awareness that technical education is a must in a modern, flourishing economy. Due to the recent recession, the need for a prepared and educated workforce may be even more critical. Therefore, the process by which high school students become interested in STEM education, pursue its curriculum and successfully transition to community colleges becomes a central issue for researchers. The focus of this review follows this process into the community college to examine how students become prepared for the workforce.

Summary of Findings:

Public or Social Policy
Recent policy by the Obama administration focuses on preparing students for the workforce. Community colleges are often those charged with this duty. As community college students are often non-traditional students, some may even be returning to college after the loss of a job. The community college is seen as the institution most concerned with a successful transition from school to work. For this reason, Carnevale (2010) asserts that much more attention needs to be paid to employment policy in relation to career and technical education. Kotamraju (2011) analyzed the return investment of the Carl D. Perkins Act with the success of career education within the community colleges. According to this Kotamraju (2011, 30) "participants in CTE programs reaped substantial returns---positive earnings---with almost nil or negative costs associated with secondary CTE (career technical education). At the postsecondary level, any associated participation costs (e.g., tuition, foregone earnings) were more than outweighed, even over the short term, by the economic payoffs of participating in CTE."

Partnerships between Community Colleges and Industry
According to Kennamer and Campbell (2011), Northeast Alabama Community College became an extremely successful institution in 2009. Local Appalachian industry had been hard hit by the

recession and local industries were suffering. By partnering with local businesses, NACC began developing programs catering to the needs of industries. NACC added tech programs and certificate training programs. In addition, they offered special assistance with counseling needs, tutoring, and financial aid. As a result, NACC became the fastest growing community college of 2009.

In a 2008 study by Torraco, both graduates and their work supervisors were interviewed to try to determine how student education could best meet the needs of employers. Supervisors reported (Torraco 2008, 225) that while "graduates were well prepared to perform commonly used procedures, they noted that graduates had difficulty with nonroutine tasks and problems encountered on the job." Due to this, the author made the recommendations of incorporating learning experiences which most closely mirrored workforce duties.

Weeks (2009, 69) observed that "community colleges have a long and impressive history of preparing a well-qualified technical workforce to meet the immediate and short-term needs of local and regional industries." He recommended that the community colleges more closely partner with corporations and employers to respond to local industry needs. Puccia et al. (2001) also focused on the necessity of community colleges to partner with industry to meet the needs of workers and employers. According to Puccia et al. (2001, 26), "Not only are students being funneled into technical programs in the community colleges designed to train them for their future high tech jobs, but the federal government, through their creation of national policies, is keeping a close watch on that training making efforts to coordinate the needs of industry, community colleges, and ultimately workers." This also "contributes to the social good."

The Business Higher Education Forum (2011) also saw the need for workforce related preparation. Iowa's community colleges have developed an Industrial New Jobs Training Program and the Iowa Jobs Training Program (Laanan et al. 2006). MacAllum and Yoder (2004) wrote of the necessity of partnership between industry and community colleges to develop an educated, prepared workforce for the 21st century.

Overall Role and Value of Community Colleges

Frey (2009) wrote of the advantages of a community college education and its preparation for the workforce or a four year degree from a university. Community colleges are notably less expensive and some even now offer residential housing for students. Hagedorn (2012) focused on STEM programs and the important role that community colleges have in the maintenance of the workforce in the current economic downturn.

Overview of STEM research and Historical Development of Technical Education

Chafy (1997) gave an overview of the historical and intellectual development of technical education while Johnson and Daughterty (2008) examined research over the prior ten year period. Lewis' (1999) review included various areas of need in research including "perceptions of technology" (p. 45) by students, "technology and creativity" (p. 46), gender, "curriculum change" (p. 48) and "integration" (p. 49), literacy, and "questions that focus on teachers," (p. 50).

Promotion of STEM Education and Technological Literacy

Just as Lewis (1999) discussed the topic of technological literacy, Lewis' 1992 research with Gagel did as well. In addition, other writers (Elrod 2010; Hall et al. 2011; Kelley 2010) wrote about the need for the encouragement of STEM programs with students. Brown et a. (2011) lamented that there is not a better understanding of STEM education overall.

Issues Related to Teachers

Four of the five articles (Dirks et al. 2004; Gibson 2012; Hansen 1996; Von Houtte 2004) portrayed technical education teachers as seeing their classes and students in an inferior light. Dirks et al. (2004) were very critical of the current methods of community college tech teachers. Van Houtte (2004) criticized the "academic culture" which demanded little of students and themselves. "It is obvious," Van Houtte (2004, 380) wrote, "that it will be very difficult to convince teachers that they should hold academic expectations as high for students in lower tracks as for students in higher tracks." Hansen (1996, 72) looked at the "differential treatment issues with respect to programs, particularly the importance and place of technology education in relation to liberal/humanist programs" and found "equity issues" related to "the way that the subjects or programs in which students register are victimized or segregated as a result of a program being misrepresented or treated in a different way than other subject areas." Gibson (2012) advocated that student teachers should be placed in a five-day block in classes focusing on technological education in an attempt to modify their misperceptions related to the subject.

Finally, McDavid et al. (2005) focused their work on the challenges facing teachers and attempted to identify difficulties they faced. These included the challenges of reporting and accountability, the increasing number of sites and demands of professional development.

Curriculum Development and Pedagogical Concerns

Many articles focused on issues related to curriculum and pedagogy. Some articles were complimentary of current programs while others recommended changes.

Kalil et al. (2010, 2010) recommended that "educators needed to be aware of, and sometimes suspend, their own customary teaching practices to discover a unique blend that would 'work for this course and these students." Additionally Kalil et al. recommended the teaching of "social literacies" which emphasized acknowledgement of one's culture, conflict management and sensitivity to cultural diversity. Other suggestions included:

a) The application of theory to practice (work-based learning) and school-based enterprises. (Clark et al. 2010; Holinner et al. 2012)
b) A "comprehensive, integrated, and granular data system" (Schoenecker 2010, 106)
c) The expanded use of Math through rural Agricultural education programs (Anderson 2008)
d) The importance of linking tech education with engineering programs (Asunda 2011)
e) An emphasis on student learning outcomes and professional staff development (Badway and Somerville 2011)
f) Success of online courses (Benson et al. 2005)
g) The "importance and value of taking high-level coursework in both mathematics and science during high school. Enrollment and attainment in physics and calculus is particularly important for all students with respect to obtaining a STEM degree down the road." (Tyson et al. 2007, 268) Others (Clark and Daughterty 2010; Wright et al. 2008)

also discuss the importance of pairing CTE with core academic work in math and science. Singer (2011) proposes interdisciplinary curriculum improvements.

h) Increase problem solving lessons into the curriculum. (Hill 1997; Ritz 2009)
i) Dual enrollment programs were examined by Kleiner and Lewis. (2005)
j) A special focus on the technology education in STEM (Harrison 2011)

Thomasian (2011) reviewed state programs and proposed that an agenda for STEM programs must be set. Four areas of social systems based upon technology (communication, construction, manufacturing and transportation) were examined by Snyder and Hales (1981).

Moon et al. (2001) were concerned with teacher training on how to improve success for students with disabilities. Other studies focused on the need for reforms which relate more to the needs of employers or the gifts of students (Atkinson and Mayo 2010; Cantor 1999; Draeger 2006) and the warning that STEM education was designed with the workforce in mind rather than the education of students (Williams 2011).

Student Characteristics, Success and Transitions

The final section of this review focuses on the students themselves. Articles generally covered the topics of the characteristics of students enrolled in the programs, research indicating student success in graduating from programs as well as successfully transitioning from high school to postsecondary programs and from those programs to universities or industry.

Zeidenberg and Scott (2011) focused on student characteristics to differentiate, by the use of transcripts, technical students from liberal arts students. Tunc's (2011) focused on the likelihood that the students may be from lower socioeconomic backgrounds and that the educational level of parents may have been low. Bragg and Durham (2012) noted also that community college students are often the under-served students. This indicated a "Catch-22," they wrote. They (p. 107) concluded that, "by offering the primary pathway to higher education for historically underserved students, including learners who are underprepared for college-level coursework and who struggle to finish, community colleges diminish their chances of demonstrating success."

Others (Alvarez et al. 2010; Godrick-Rab 2010; Prince 2008; Ryden 2006) also addressed the underserved or nontraditional nature of community college students. Prince (2008, 65) was critical of Washington State's handling of these students and suggested that "community colleges need to rethink and redesign policies and practices in order for more low-skill adults to reach the one-year college-credit milestone." Godrick-Rab (2010) noted that for some students might not have had an opportunity for education if it had not been for the community college. Jacobson and Mokher (2009) write about the impact of potential earnings for low-income community college students. Ryden (2006) noted the importance of "re-entry pathways for first generation college students."

Some authors focused on female students (O'Riley 1996; Silverman and Pritchard 1996; Weber 2011) and advocated female role models and mentoring for girls. Silverman and Pritchard (1996) recommended also that as many girls as possible should be scheduled in one class together, that women who work in the field need to be seen by the girls and guidance counselors

should encourage girls in nontraditional fields. Weber (2011) also noted the necessity for role models for female students while Gorman et al. (2010) echoed the need for women professionals to mentor female students. O'Riley (1996) stated the need for new narratives to be told which would indicate the diversity of the students. She felt that the collective story told to students and potential students is limited by racism and sexism, as well as not reflecting some experiences of rural workers. Townsend (2009) also asserted that community colleges needed to provide a supportive climate for minorities and women students. This included the importance of changing discourse about women and minorities and the representation of minority and women faculty who are paid equitably. Success in STEM will increase "racial and ethnic equality," according to Beede et al. (2011). Rule et al. (2011) and Garrison-Wade and Lehman (2009) wrote of the necessity to support STEM students possessing disabilities.

As indicated in the prior section, problem solving skills were seen as important and Wu et al. (1996) focused on the necessity of these for student success. Roman et al. (2010) focused on student retention. Cooperative training programs (Gonzales 2011) were seen also as facilitating student success by increasing students' income potential and retaining their interest. Gantt (2010) focused on encouraging mentoring programs and retention plans to encourage student success. Other recommendations included an alumni or former student association. Also essential, according to Hirschy and Castellano (2011) to retaining student interest is "career integration," whereby the student can see how his or her education blends with workplace responsibilities and demands. Heillbronner (2011) cited the student's belief in his or her own success in the program as well as challenge and preparation as factors impacting the decision of "talented" students to major in STEM.

Other authors wrote of transitions from high school to college (Dare 2006; King 2009) and students transitioning from community colleges to universities (Bliz 2012; Burn and Gerhard 2011). According to these authors, the transition time for a student is an especially challenging one and efforts must be made to offer support and assistance during these times. According to Dare (2006, 73), "Once considered a track for non-college-bound high school students, CTE has evolved to include an increased emphasis on rigorous academic preparation and integrated and articulated CTE courses and programs…Today,, many high schools offer CTE that requires advanced academic skills to help students make the transition to college level technical and professional studies." The transition, therefore, may be more challenging than before and the student may require additional assistance to become successful. The pathway to success, therefore, is essential to discern for the student, the educational institution, the workplace and society. The Business Higher Education Forum (2010) remains interested in the pathway to success for students in the STEM field and continues to encourage graduation and successful careers.

Gaps in the Literature and Suggestions for Further Research

1. Little information was gathered by speaking with community college instructors. Much research needs to be done to gather insight from these professionals.
2. While researchers discuss the "non-traditional" nature of the community college students, little has actually been shown about the particular challenges and obstacles they face, whether these are in their personal lives or their academic careers. There is much we can learn about their lives and their strategies for dealing with these challenges.

3. There is much we can learn also by looking at different pathways into STEM majors and careers. Some students may come directly from high school while others may enter the field after other careers or life challenges.
4. While some attention was given to female students, we can still learn more about how social location (ie., gender, race and ethnicity, socioeconomic status) can impact a student's experience.
5. We need to learn more about the connections between community college educators and workforce employers and supervisors.
6. We can learn a great deal from students about successful paths and transitions, learning methods and relationships with college instructors that are helpful to the process.
7. Little was discovered about college administrators with relation to the programs we are studying.

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