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Advancing STEM Career and Learning Through Civic Engagement

The Mayor's Youth Technology Corps (MYTC)—Creating Safe Communities through Information Technology Training in Homeland Security Applications (2008–2012)—offered a collaboration of resources, supports, and opportunities for strengthening science, technology, engineering, and mathematics (STEM) education efforts in an underserved community, the City of Detroit. This MYTC project achieved three important goals: (a) creating career pathways for two cohorts of 50 high school students (100 total) in geographical information system (GIS) and information technology in the context of application development concerning homeland security and facility management, (b) providing students with inquiry-based STEM learning opportunities through multiple delivery methods, and (c) enhancing students' hands-on working experiences by offering internships in City of Detroit organizations. By the end of the MYTC project, around 814 students had participated in various activities sponsored by the project and more than 20 teachers served as lead teachers. Among them, 162 students graduated from the summer institutes; 120 students completed in-class, after-school, or online GIS training courses; 84 students went through a hybrid information assurance course; and 98 students successfully finished their internship assignments. A STEM career goal measure showed that overall interest in having a career in STEM increased 9% throughout the program, and there was an additional 10% increase as a result of the internships.

The MYTC internship program is an important form of student civic engagement and also the highlight of hands-on experiences for the MYTC trainees. The internship is the capstone and a true test of how the MYTC students were trained and whether the students were learning what was designed for them in this project. Moreover, the internship program aimed at advancing the participating students' motivation toward STEM careers. This paper examines the rationale for selecting the internship as the MYTC project's capstone and the lessons learned through the internship program implementation. The need for an advanced technology-based internship is discussed in the second section. The research design of how to examine critical factors of the internship implementation is presented in the third section. The outcomes of the internship program is are assessed in the fourth section. The lessons learned and future improvements will be discussed in the final conclusion section.

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The Significance of Promoting Student Civic Engagement Through Information Technology Based Internships

The employment situation has been dreadful in the Detroit metropolitan area. "Southeast Michigan, and the State of Michigan as a whole, is currently in the midst of serious structural economic trouble. The region has lost jobs since 2000 especially in the auto manufacturing sector" (Southeast Michigan Council of Governments [SEMCOG], 2008, p. 19). Although this region is recovering from a decade-long deep recession, the recovery will be longer and slower than in the past (SEMCOG, 2012). Moreover, the minority communities have been suffering disproportionally in job loses (Shapiro, Meschede, & Osoro, 2013). Among the total population (617,832) of the City of Detroit, 83.7% are African American (U.S. Census Bureau, 2013). Creating and enhancing resources and exposures to careers in science and technology for 65,632 high school students between the ages of 15 and 19 in Detroit (U.S. Census Bureau, 2013) is an extremely challenging but necessary task.

In order to generate STEM learning motivation and create STEM career opportunities for the urban youth, Eastern Michigan University (EMU), the City of Detroit Information Technology Services (ITS), the City of Detroit Office of Homeland Security and Emergency Management (HSEM), and Detroit Public Schools (DPS) came together and developed the MYTC project based on four considerations: (a) demonstrating to the high school students that there are bright career opportunities in information technology and, in particular, GIS; (b) engaging them with real tasks that were in great demand in their own communities; (c) enabling them to have workplace experiences by providing them with paid internships; and (d) motivating their interests in learning STEM in school and seeking STEM careers in the future. We were awarded a grant Innovative Technology Experience for Students and Teachers (ITEST) program, which is funded by the National Science Foundation (NSF), to implement this design.

At the beginning of the new millennium, information technology (IT) was exploding. Three occupations related to IT were listed among the top ten fastest growing occupations: Employment of network systems and data communication analysts was predicted to grow 57% from 2002 to 2012 (the second fastest); employment of computer software engineers–applications was expected to grow 46%, the eighth fastest; and the employment of computer software engineers–systems software was expected to grow 45%, the ninth fastest (U.S. Department of Labor, Bureau of Labor Statistics, 2004). Moreover, "because the uses for geospatial information technology were so widespread and diverse, the market was growing at an annual rate of almost 35 percent, with the commercial subsection of the market expanding at the rate of 100 percent each year. (Geospatial Information & Technology Association)" (U.S. Department of Labor, Employment and Training Administration, 2010).

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> Geographic information systems (GIS)—and the analytical tools for using these systems wisely—now play a fundamental role in the provision of emergency services, transportation and urban planning, environmental hazard management, resource exploitation, military operations, and the conduct of relief operations. In the years ahead, geographical tools and techniques will be of vital importance to the effort to monitor, analyze, and confront the unprecedented changes that are unfolding on Earth's surface. (National Research Council, 2010, p. ix)

Geospatial (GIS, global positioning system, and remote sensing) technology, along with nanotechnology and bio-engineering, was cited as one of three emerging industries (Gewin, 2004). Using emerging technologies was found to be an effective approach to facilitate science learning and civic engagement (Green, 2012).

In addition, almost all enterprises were using the Internet to disseminate location-related (geographic) data in map forms using Web GIS (Green, 1997; Rohrer & Swing, 1997; Peng & Tsou, 2003). With the increasing popularity of global on-line mapping web applications (e.g., Google Maps, Microsoft Virtual Earth, Yahoo Maps, ArcGIS Online), Web GIS was part of "business exchange," and there was an ever-growing volume of literature and public participation (e.g., Carver, 2001; Clark, Monk, & Yool, 2007; Kulo & Bodzin, 2013). Therefore, there was no better time for youth to be part of IT and GIS because the information technology field (including geospatial technology) was expanding at an exponential rate. Career opportunities were virtually unlimited, as was the range of businesses in which computer skills could be utilized. Banking, engineering, film production, forestry, health, homeland security, manufacturing, management consulting, and mining—practically every industry—were now using computers and needed people to manage, use, network, or program them. Technical skills were also very portable, a circumstance that made a career in information technology very attractive to people who liked to experience different cultures. Moreover, computers and the networks that connect them were inescapably part of our lives.

Demonstrating the use of IT and GIS to the urban youth in the underserved community of Detroit was particularly mindful (Xie and Reider, 2014). The cultural dimension of IT and GIS integration in education and society was worth special attention. The applications of IT and GIS tools in education and society could neither be seen apart from their objectives nor be considered apart from the cultural-historical contexts in which the human subjects participated (Leidner & Jarvenpaa, 1995; Kali, 2002; van Eijck & Roth, 2007; Literat, 2013). Above all, IT and GIS were about people sharing information and innovative ideas that eliminated global barriers and helped increase the availability of information to everyone. IT went far beyond standard classroom learning (or formal education). After-school programs or informal education opportunities, alternatively, created environments that could effectively inspire, augment, and

https://doi.org/10.21061/jte.v26i1.a.3

reinforce science and technology learning for school children. They were creating the kind of "intentional figured communities" seen as essential in Teresa Perry's theory of African-American achievement (Perry, 2003).

Second, an important civic engagement component was to involve the students with real tasks that were in great demand in their own communities. GIS, as a unique sector of information technology, was continuously expanding its scope of applications in almost every aspect of our society and increasing its power of problem solving along with the rapid advancement of information. Furthermore, the current economic slowdown and high unemployment made the civic engagement component much more significant, outstanding, and relevant. In 2013, the City of Detroit implemented furlough days in order to solve the budget crisis (Associated Press, 2013). Trained MYTC interns were widely welcomed by the city organizations that hosted them. The internship supervisors in these departments, as well as the department directors, expressed their appreciation to the NSF ITEST program for the funding support to the MYTC project in Detroit. They strongly believed that this support from the NSF ITEST program helped them fulfill not only temporary vacancies but also an important city government mission, providing opportunity of training Detroit youth in technical careers. No doubt, the long-term support from NSF was critical for developing STEM learning and career projects in our communities (Burns, 2013).

Third, the internship program implemented *place-based learning* to establish natural linkages between technologies and neighborhood socioeconomics (Elder, 1998; Krapfel, 1999; Wessels, 1999). In other words, the project activities were occurring in the students' milieu (Hunter & Xie, 2001; Henry & Semple, 2012). As students participated in project activities (i.e., learning IT and GIS and applying them in city organizations), they would enhance their STEM learning by becoming community citizens and by helping the hiring agencies to conduct IT- and GIS-related jobs or tasks. Thus, the project provided an opportunity for students to use their own community as a platform for learning, which allowed them to create "a set of building blocks from which to construct a life" (Nabhan & Trimble, 1994, p. 131).

Fourth, the civic engagement—internship—enabled the participating students to have workplace experiences and to earn some stipends through paid internships. Hands-on learning activities inspired a sense of excitement, adventure, and emotional engagement for learning (National Research Council, 2005). Income has been found to be directly correlated to the recruitment and retention of students in STEM programs in urban areas, where income amongst households is relatively low (Dayton, Raby, Stern, & Weisberg, 1992; Neumark & Rothstein, 2005). Thus, "learning with earning" (the paid internship) was intended to motivate students to attend IT and GIS training.

Finally, all of the above activities motivated the students' interests in learning STEM in schools and seeking STEM careers in the future. A review of

https://doi.org/10.21061/jte.v26i1.a.3

the current literature revealed that classroom science engaged only a small percentage of students and involved even fewer low-income, female, or minority students (Tobin, 2005; National Research Council, 2011). Therefore, demonstrating the bright future of STEM careers in IT and GIS, encouraging them to help solve the issues their communities were facing, and enabling them to have workplace experiences were purposefully advancing their interest in STEM careers and learning. In other words, the individuals' perceptions of their current and imagined future opportunities were serving as motivators and organizers for their current task-related thoughts, attitudes, and behaviors, thus linking current specific plans and actions to future desired goals (Stake &Mares, 2005). As such, workplaces and communities proved to be more optimal places of learning for minority and low-income as well as female students.

Research Design: How to Examine Critical Factors of the Internship Program

During the MYTC project, 115 students completed the required technology and discipline training for the internship. Among them, 104 were placed as the MYTC interns, and 98 successfully completed their internship assignments in 14 organizations located in the City of Detroit (Table 1). Among numerous factors, we found that the following determinants were critical for successfully implementing the MYTC civic engagement component, the internship: cooperation of key stakeholders, promise of future career, societal satisfaction, provision of service values, technical skill, adequate discipline, and governmental and public support. Under the guidance of the Simpson-Troost Attitude Questionnaire (STAQ), three sets of tests were developed in order to examine these determinants (Simpson & Troost, 1982; Simpson & Oliver, 1985). Good literature reviews about STAQ were provided by Owen et al. (2008) and Liaghatdar, Soltani, and Abedi (2011).

https://doi.org/10.21061/jte.v26i1.a.3

Table 1
List of Organizations in the City of Detroit Hosting the MYTC Interns

Intern Hosting Organizations	# of Interns Hosted
City Department of Water & Sewage	31
City Fire Department	23
Essential Learning Services	11
DTE Energy	8
City Department of Environmental Affairs	4
City Department of Transportation	4
Detroit Public Schools	4
City Department of Human Resources	4
City Homeland Security & Emergency Management Office	3
City Department of Creative Communications Services	2
Governor's Office in Southeastern Michigan	1
City Department of Health & Wellness Promotion	1
City Information Technology Service	1
City Department of Public Lighting	1
Total	**98**

The first test was a preinternship survey of 27 students who were about to start the internship. The survey questions mainly concerned the reasons why they wanted to participate in the MYTC internship program (Figure 1). For the second set of tests, we surveyed the same 27 students at the internship workplaces about their general reflections on their internship experiences. We also surveyed these interns' supervisors at the hiring agencies (n = 10) about the organizational reflections of the student interns. We compared the two sets of general reflections in Figure 2.

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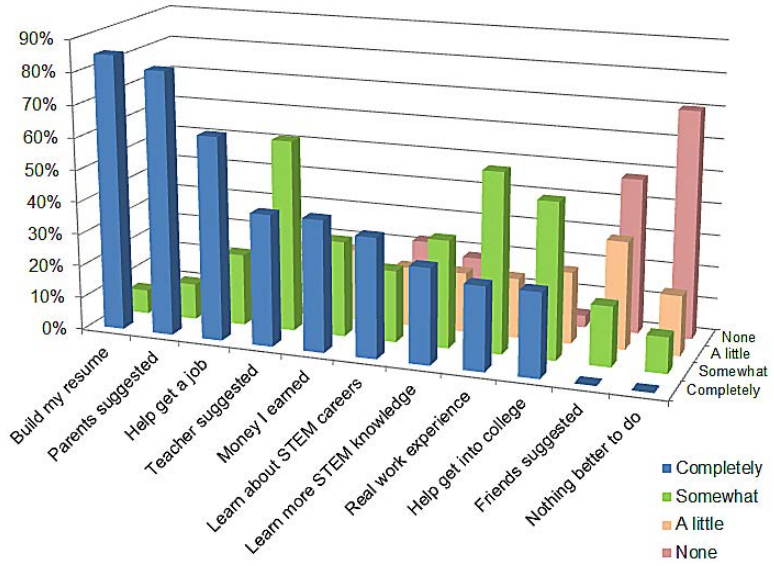

Figure 1. Reasons why students wanted to participate in the internship program

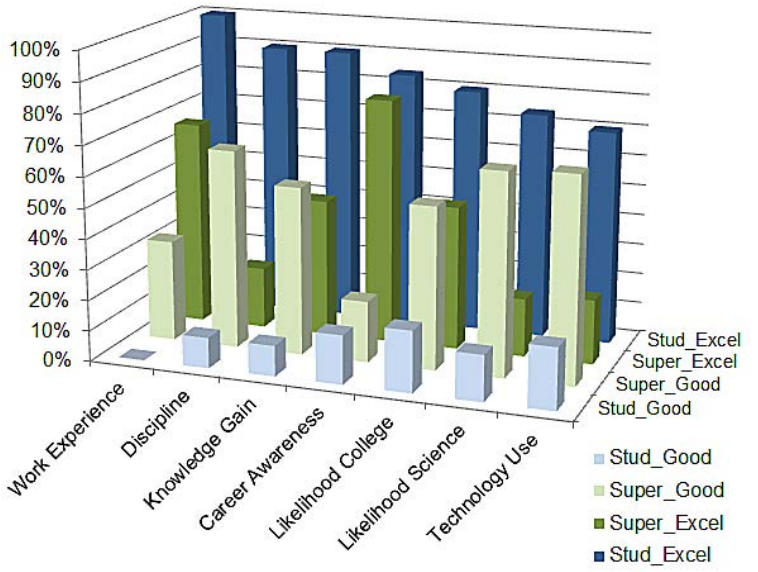

Figure 2. General reflections of the internship program from the participating students and agency supervisors

https://doi.org/10.21061/jte.v26i1.a.3

As a follow up, we interviewed the same 27 interns and 8 supervisors with the same set of questions pertaining to specific outcomes of the MYTC internship assignments. The responses from the interns are reported in Figure 3, while the correspondences from the supervisors are reported in Figure 4.

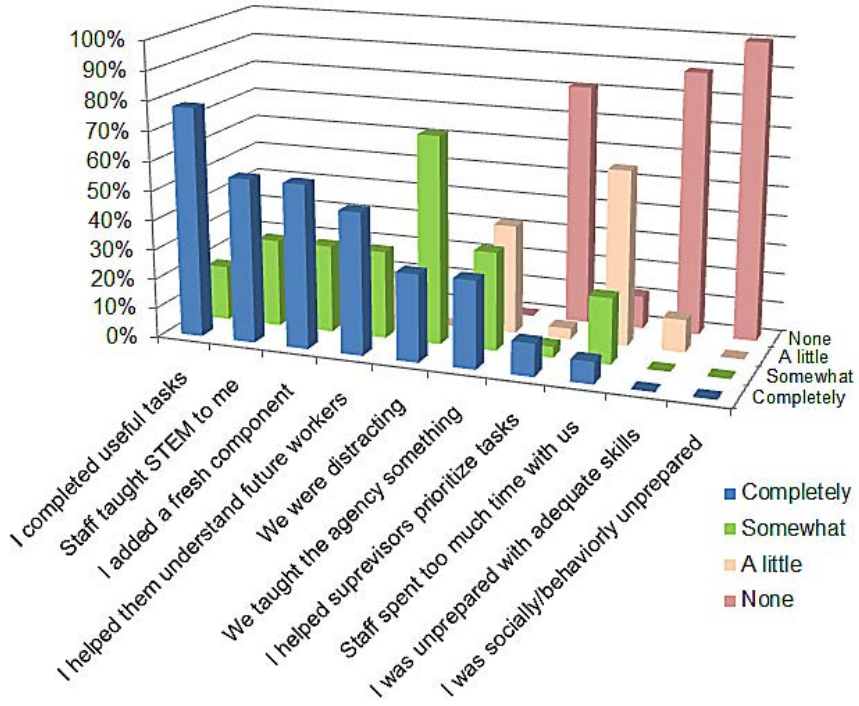

Figure 3. The self-assessment of the internship experience by students

The third evaluation tool was comprised of the pre- and post-intern surveys, which were specifically designed to examine how the internship experience changed the students' perception about STEM careers (Table 2). The pretest survey was required for all of the MYTC interns when they started their internship assignments at the hiring organizations. The posttest survey was carried out when the MYTC interns completed their assignments.

https://doi.org/10.21061/jte.v26i1.a.3

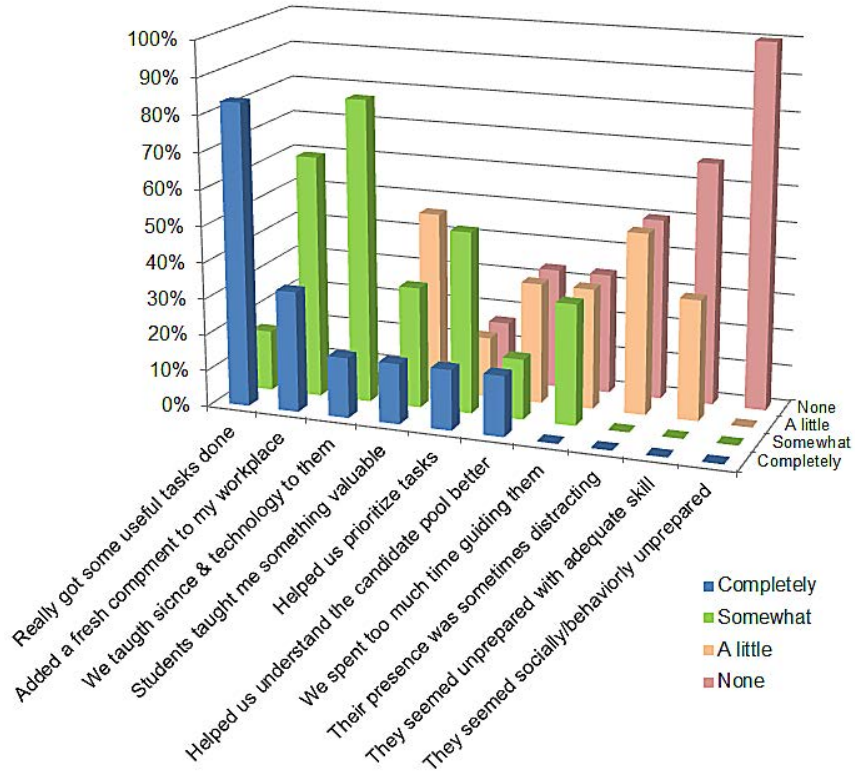

Figure 4. The assessment of students' internship experience from agency supervisors

Assessment of the Internship Outcomes

Cooperation among key stakeholders was the most important driving factor for the successful execution of a civic engagement project (the MYTC internship program in this case). Education in schools played a significant role in leading students into civic engagement (Kennedy, 2013). Teachers were mentors and facilitators to students' engagement in civic activities (Lozano, Gutierrez, & Martos, 2013). It was also critical to connect schools with universities and communities for the success of a civic learning project (Vogt, 2013). The social organization was particularly important for expanding minority student participation in civic engagement activities (Farmer, 2006; National Research Council, 2011). These arguments were all confirmed in the MYTC internship program. The active participation of the organizational internship supervisors in the assessment and their positive evaluations of the internship program provided good evidence of the internship success (Figure 2

https://doi.org/10.21061/jte.v26i1.a.3

and Figure 4). We found that the shared vision, ownership, resources, and support among local and regional stakeholders guaranteed the success of the MYTC internship program.

From the very beginning of the MYTC project, a formal internship agreement was signed among Eastern Michigan University (EMU), the City of Detroit Information Technology Services (ITS), the City of Detroit Homeland Security and Emergency Management (HSEM), and Detroit Public Schools (DPS). The main points of this cooperation agreement included:

- DPS would designate A. Philip Randolph Career/Technical Center (CTC) as the manager of the MYTC internship program. CTC would select trainees, teach trainees about workplace ethics, process paper work (including the MYTC Internship Agreement, Internship Application Form, Employment Authorization Form, W-9 Form, Parents Consent Form, Liability Release Form, and Intern Transportation Request Form), and monitor internship timesheets;
- EMU and the MYTC project staff team would prepare MYTC trainees with adequate GIS and information technology skills through in-class sessions, afterschool trainings, and online virtual courses as well as provide technical support to MYTC interns at the workplace if needed;
- EMU through the NSF ITEST grant would pay $1,200 per internship for MYTC interns who had adequate GIS skills and workplace ethics and successfully completed workplace assignments with120 hours;
- HSEM would act as the liaison between the MYTC project and City of Detroit departments and organizations to place interns in the City of Detroit; and
- ITS would designate an Internship Coordinator to oversee the internship program, would provide the intern with a letter of completion for future job applications upon an intern's successful completion of the workplace assignments and would, at its discretion, arrange continued employment in a city department or organization.

The promise of future career opportunities was the most attractive incentive for students' participation in the internship program, confirming the findings of Stake and Mares (2005). More than 83% of the surveyed interns completely agreed that "build my resume" was the top reason for their participation in the internship (Figure 1). The majority of them felt very positive about their workplace experiences (Figure 2, the last row). Eighty percent of them had excellent reflections about "work experience," "discipline training," "knowledge gain," and "career awareness." In addition, the internship supervisors ranked "career awareness" as their top reflection of the interns' achievement (Figure 2, the second to last row).

Societal satisfaction was often neglected in the literature concerning the reasons for community support to students' civil engagement (Grillo, Teixeira, & Wilson, 2010; Zaff, Boyd, Li, Lerner, & Lerner, 2010). We recognized the

https://doi.org/10.21061/jte.v26i1.a.3

importance of winning support from the students' parents and communities. So, we organized bimonthly briefings for teachers, parents, and community leaders, informing them about the progress of the project implementation, including training activities, internship processes, and career opportunities. As a result, we had strong support and high satisfaction from the communities. For instance, the students were strongly encouraged by their parents and teachers to participate in the internship program (Figure 1). The internship supervisors were very positive about the program and contributions of the interns (Figure 4).

The provision of service values was another important factor to gain community support for student civic engagement projects (Prentice, 2007). The majority of the interns were confident about the contributions they made to the hiring organizations. They gave high marks to the interview questions, "I completed useful tasks," "I added a fresh component," and "I helped them understand future workers" (Figure 3). Furthermore, their supervisors agreed with them. More than 80% of the supervisors completely agreed that the interns really did complete useful tasks (Figure 4).

Well-trained technical skill was a prerequisite for a student to succeed in a civic engagement project and especially in an information technology based one (Henry & Semple, 2012). However, the consciousness of civic duty and discipline was as important as the technical skill for successfully participating in civic engagement activities (Zaff et al. 2010). In addition to gaining practice using technology skills acquired in the program, the students learned about the workplace culture, including discipline, respect, how to dress, how offices and departments function, and a range of other operational and experiential details not easily communicated in a typical school setting. Notably, both interns and supervisors reflected the equal importance of skill and discipline in their responses to the interview questions (Figure 3 and Figure 4).

Another point we wanted to emphasize was the significance of governmental and public support in the success of the MYTC internship program. The internship program proved one of the most compelling and rewarding components of the MYTC project. The stipends for the interns were paid out of the NSF ITEST grant. Therefore, it was very important to have the NSF ITEST program support in order to carry out the MYTC project in the City of Detroit.

Finally, from the pre- and post-surveys, we assessed how students felt about future careers. When asked, "What kind of job do you expect to be doing when you grow up? (check the ONE job category you would be MOST interested in doing)," changes in different categories suggest that program participation had some impact on their perceptions of their future job aspirations. Students who completed the internships also showed slightly more changes in areas related to STEM skills (Table 2).

https://doi.org/10.21061/jte.v26i1.a.3

Table 2
The Pre- and Post-Surveys of the Students' Career Goals (n = 98)

Survey questions about career goals	Pre	Post	Change
Science and Engineering (like scientists, engineers, computer programmers)	18%	28%	10%
Medicine (like nurses, doctors, physical therapists, dentists)	18%	19%	1%
Architecture and Construction (like builders, planners, architects)	4%	4%	0%
Finance (like bank tellers, economists, financial managers, insurance agents)	2%	2%	0%
Agriculture and Natural Resources (like park rangers, farmers, gardeners)	0%	0%	0%
Not Working	0%	0%	0%
Business and Marketing (like accountants, file clerks, office managers, and receptionists)	14%	13%	-1%
Education and Counseling (like coaches, teachers, librarians, psychologists)	10%	9%	-1%
Government, Law, Security (like lawyers, police, inspectors, politicians, postal clerks)	8%	7%	-1%
Don't Know	4%	3%	-1%
Transportation (like pilot, truck driver, auto mechanic)	2%	1%	-1%
Arts, Entertainment, Sports, Communications, and Tourism (like chefs, athletes, artists, singers, fashion designers, travel agents)	12%	10%	-2%
Manufacturing and Repair (like forklift operators, welders)	8%	4%	-4%

Conclusions and Discussion

Connecting the information technology training (GIS in particular) to paid positions in the form of internships and civic engagement provided not only real-world problem-solving experiences but gave the students a sense of what an actual job looked like and how one should behave, dress, and communicate in the workplace. The program received encouragement from teachers, endorsement from parents, and praise from internship supervisors. The internships provided a tangible end goal for students during their year(s) of engagement, and they always had a sense of where it would lead them.

Students of the target population in this underserved urban community had great drive when it became clear to them that the learning materials were relevant and technological and would increase job and career opportunities. In

https://doi.org/10.21061/jte.v26i1.a.3

addition, internships provided a critical platform for students to immediately demonstrate and put into use their newfound knowledge, while contributing useful work to the City of Detroit and getting paid for doing it. Furthermore, interns built up resumes, established professional contacts, and gained on-the-job experiences beyond technology. Ideally, a program related to building STEM skills toward career alignment should have an internship component.

We assessed several factors influencing the internship program. Noticeably, the evaluation data from both interns and their workplace supervisors showed that the critical factors for successfully implementing the MYTC internship program were: cooperation of key stakeholders, promise of a future career, societal satisfaction, provision of service values, technical skill, adequate discipline, and governmental and public support.

The internships' impact on participants' future perception of STEM careers, as described by the data analysis in the fourth section, was significant. As a result of the internship experiences, a good number of students started seriously thinking about STEM career options in tangible ways, including future study.

However, there are some other lessons we learned from the MYTC project. The scalability of the MYTC civic engagement (the internship) is a challenging question because the stipend for the interns came from a NSF ITEST grant. Therefore, simple adaptation of a similar civic engagement is unlikely in other metropolitan areas. Thus, the scalability of such a project will depend upon local municipal needs and resources to support paid internships, which proved to be an important incentive in the underserved community of Detroit.

A couple of findings are worth further discussion. The MYTC project provided funding to City of Detroit municipal departments and organizations to hire participating students as interns; in turn, students contributed to real-world applications and solutions. Each supervisor reported that the internship provided an extremely cost-effective option to recruit, train, and employ high school and precollege students. Their interest was not so much in getting work done with the payment from someone else as it was in recruiting and training those who might become their future pool of employees. As a result of the serious city deficit experienced in Detroit during the program years, not many municipal departments had funding to support interns beyond the program's end. Only four interns continued their employment on the city payroll. However, each supervisor interviewed pledged that in different circumstances, they would rush to develop internship programs based on the successes they saw with MYTC. We believe that the municipal and business communities of major cities would find this model viable and rewarding with additional ties to service learning and workforce development. In the future, we need to look into how to build an organizational structure in order to provide sustained financial resources to support students' participation in civic activities in underserved communities.

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