The Use of Regional Data Collection to Inform University Led Initiatives: The Case of a STEM Education SWOT Analysis

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Abstract

According to the National Science Foundation (NSF; 2006), science and engineering jobs constitute a growing sector of the United States economy. The number of science and engineering degrees has lagged behind this occupational growth. In describing Wisconsin's technology profile, Winters, Strang, and Klus (2000) report that the state is nationally ranked 23rd in the number of Ph.D. scientists produced and 26th with regard to the number of Ph.D. engineers produced. Thus, enlarging the science, technology, engineering, and math (STEM) pipeline in Wisconsin is vital to increasing and maintaining its economic stature. This objective is perhaps most important in the seven-county region of southeastern Wisconsin (M7), as it accounts for 34% of the state's workforce, and, according to the 2000 Census, is the most racially diverse area of the state. As such, this paper assesses the status of STEM affairs in Wisconsin's M7 region in an effort to provide an environmental scan of its readiness to be reframed as a STEM corridor. A strengths, weaknesses, opportunities and threats (SWOT) analysis is conducted to understand how to: (a) boost student participation in STEM at all educational levels in the M7 region, (b) increase STEM participation in order to bolster industry hiring in the region, (c) convince more STEM graduates to remain in the M7 region and attract STEM professionals on the whole, and (d) gain a greater understanding of the activities or initiatives that cement cooperative relationships among STEM organizations.

I STEM, Education, University, SWOT

While postsecondary enrollment has increased within the United States over the past decade, the proportion of students obtaining degrees in science, technology, engineering, and mathematics (STEM) fields has fallen. Approximately 519,000 students obtained STEM degrees in academic year 1994–1995, which represented 32% of all degrees awarded at the time. In academic year 2003–2004, approximately 578,000 students obtained STEM degrees, which represented 27% of all degrees awarded (Ashby, 2006). When college and university officials were asked why STEM participation percentages are falling, they cited subpar teacher quality and poor high school preparation as factors that discouraged the pursuit of STEM degrees, with follow-up studies advocating for increased enrollment in STEM fields through more outreach and mentoring programs. Subsequently, Congress established new grants to encourage students from low-income families to enroll in STEM fields and also created an Academic Competitiveness Council to identify, evaluate, coordinate, and improve federal STEM programs (Ashby, 2006). These funds, however, have not resulted in significant changes.

The federal government is very much invested in increasing STEM participation throughout the U.S, including in Wisconsin. In fiscal year 2004, it spent approximately $2.8 billion to fund over 200 programs designed to increase the numbers of students in STEM fields and employees in STEM occupations in addition to improving related educational programs. The National Institutes of Health (NIH) and the National Science Foundation (NSF) account for nearly 50% of all of these programs (Ashby, 2006). Moreover, women now outnumber men in college enrollment, and minority students are enrolling in record numbers at the postsecondary level. To the extent that these populations have been historically underrepresented in STEM fields, they provide an untapped source of STEM participation. Specifically, the seven-county region of southeastern Wisconsin, the M7 region, can benefit from tapping into these populations and building a strong STEM workforce within the area.

Despite the importance of STEM educational opportunities in the M7 region, information about these programs in the area remains decentralized and disjointed, with Wisconsin's top math and science education personnel failing to identify comprehensive, in-state resources for potential STEM participants. In response to this state of STEM affairs, the Regional Task Force on STEM Education has commissioned this strengths, weaknesses, opportunities, and threats (SWOT) analysis in an effort to provide an environmental scan of the readiness of the M7 region to be reframed as a STEM corridor. The overarching goals of this analysis are to understand how to: (a) boost student participation in STEM at all educational levels in the M7 region, (b) increase STEM participation in order to bolster industry hiring in the region, (c) convince more STEM graduates to remain in the M7 region and attract STEM professionals on the whole, and (d) gain a greater understanding of the activities or initiatives that cement cooperative relationships among STEM organizations.

Method

Qualitative inquiry is appropriate for studying a phenomenon for which researchers have very little previous empirical knowledge (Shank, 2002). Creswell (2002) states that "qualitative research examines a research problem in which the inquirer explores and seeks to understand a central phenomenon" (p. 52). As little is known in the literature about said phenomenon, researchers use data from participants to develop foundational knowledge. In order to achieve this goal, they often use a comprehensive interview protocol that involves asking open-ended questions (Brenner, Brown, & Canter, 1985; Flowers & Moore, 2003; Rubin & Rubin, 1995).

The Internet has become a popular medium for finding, retrieving, and exchanging information for use in research (Crossman, 1997; McFadden, 2000). Specifically, Flowers and Moore (2003) found that collecting qualitative data on the Internet increased efficiency and accuracy by eliminating the time needed to transcribe audiotapes. This particular study employed e-mail interviews for data collection, a method to which Creswell (2002) speaks: "E-mail interviews consist of collecting open-ended data through interviews from individuals using computers and Web site or the Internet" (p. 207). It is an approach that is recommended when researchers need to collect data from a geographically dispersed group of people. Accordingly, e- mail interviews were used in this study.

Data Collection

E-mail interviews were administered via a web-based data collection site. To develop our pool of participants, the researchers sent e-mails to STEM professionals in the M7 region, requesting names of appropriate individuals for this study. Upon receiving these names, each potential participant was sent an e-mail explaining the purpose of the study. As the e-mail message asked individuals for their participation, it included a direct link to the data collection website. The e-mail interview protocol took participants approximately 20 minutes to complete, the data collection process on the whole yielding 192 completed interviews.

Data Analysis

Emergent themes were analyzed using Conrad's (1982) constant comparison method, especially those associated with elucidating this study's research questions. These themes were labeled and described independently by the researchers, cross-verified, relabeled, and then defined. Each researcher then reexamined the original transcripts for separate verification of the presence of the emergent themes. Original transcripts from these data were extracted as supporting evidence for each theme. The researchers then combined findings from the separate analyses to produce a final description of each theme alongside its properties and dimensions.

Participants

Participants included 192 STEM professionals employed within the M7 region. Because there is little research on this group of professionals within this specific region, it is difficult to assess how truly representative the sample is. Those interviewed were treated in accordance with the Ethical Principles of Psychologists and Code of Conduct (American Psychological Association, 2002). No participant names or other identifying characteristics were reported in the study's results.

Protocol

The E-mail Interview Protocol for STEM Education in the M7 Region was developed to ensure that these data would be used to perform a SWOT analysis. Items on the e-mail interview protocol were based on a comprehensive literature review that addresses STEM education and professionals. Excepting questions concerning demographic information, the protocol consisted of open-ended questions and was divided into four sections: (a) demographic information, (b) STEM educational opportunities, (c) strengths and weaknesses of STEM education in the region, and (d) opportunities and threats for STEM education in the region.

Pilot testing of the e-mail interview protocol was completed using five STEM professionals in the M7 region. Respondents were asked to complete the e-mail interview protocol, provide comments on the clarity of statements, and identify other items that they felt should be included. The researchers subsequently analyzed these comments, reviewed the feedback, made necessary revisions, and revised the e-mail protocol.

Ethnicity/Gender

Given severe underrepresentation of racial and ethnic minorities of the STEM community within the M7 region, only 20% of survey respondents identified as racial and ethnic minorities. The remaining 80% self-identified as White, that is to say not of Hispanic origin (see Figure 1). When examining gender of professionals in STEM and STEM-related disciplines within the M7 region, 57% of the respondents were male and 43% of the respondents were female (see Figure 2).

Employment Categories

Of the participating professionals in STEM and STEM-related disciplines within the M7 region, survey respondents were categorized within nine employment sectors (see Table 1). Table 1 details these employment categories with corresponding percentages of employment/participation. Out of 192 survey respondents, approximately 80% were located within the education sector, which included higher and continuing education, K–12, distance learning, and extension services within local communities. The second largest concentration of categorical participation was the health sector. An overwhelming majority—96% of the respondents—currently works in a STEM or STEM-related discipline (see Figure 3). Among these disciplines, most prominent were: (1) technology education, (2) engineering, (3) mathematics education, (4) computer science, (5) computer security and systems analysis, (6) nursing, (7) media/broadcasting, (8) chemistry, (9) biotechnology/biomedical research, and (10) medicine.

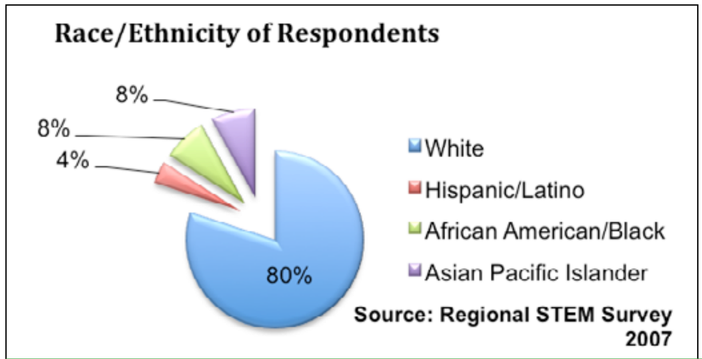

Figure 1.

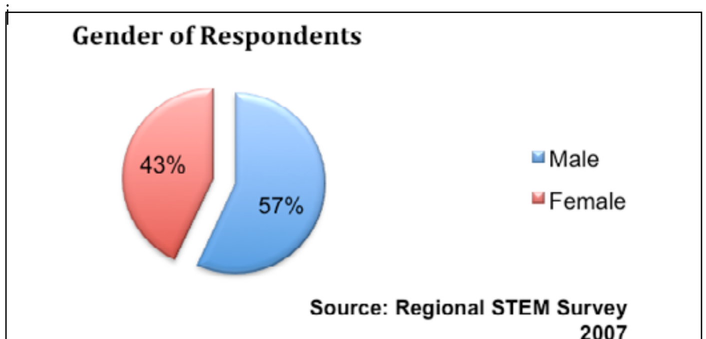

Figure 2.

Employment Categories of STEM Disciplines for Respondents

Category	Percentage
Chamber of Commerce	1%
Construction	1%
Criminal Justice	1%
Education (Higher, K-12, Distance)	80%
Financial	1%
Government	2%
Health	6%
Information Systems	2%
Legal	2%
Major Corporation/Small Business	1%
Non-Profit	2%
Utilities	1%

Table 1.

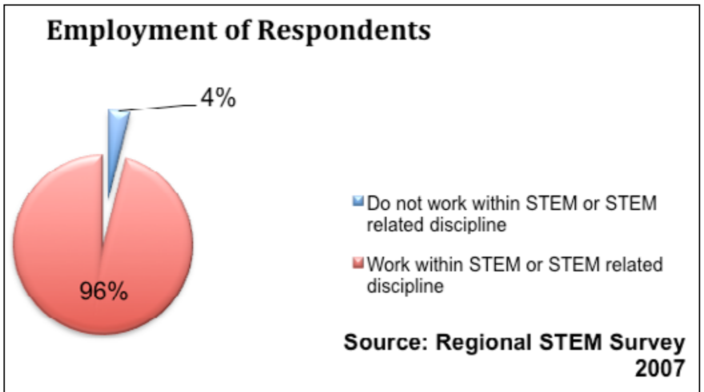

Figure 3.

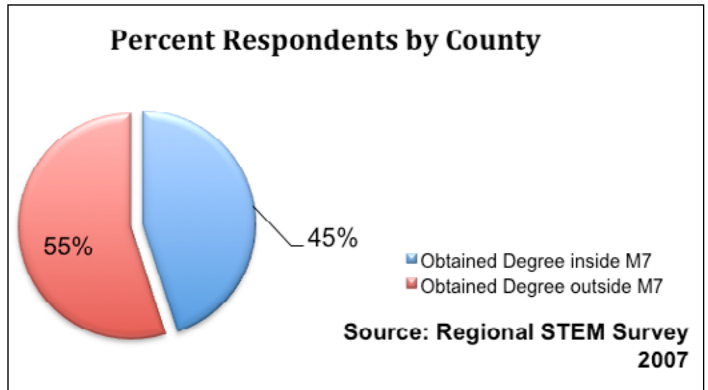

Figure 4.

Percent Respondents By County

County	Percentage
Kenosha	2%
Milwaukee	74%
Ozaukee	4%
Racine	6%
Walworth	1%
Washington	2%
Waukesha	7%
Other	4%

Table 2.

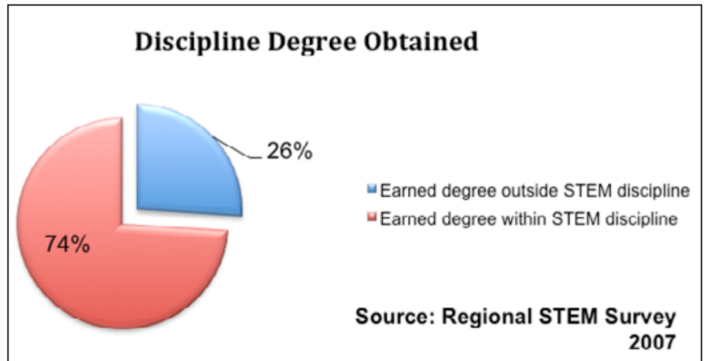

Figure 5.

Degrees: Stem and STEM-Related Disciplines
Percent Respondents By County

Actuarial Science	Manufacturing Engineering
Agricultural Engineering	Marine Biology
Technology	Mathematics
Applied Geochemistry	Mechanical Engineering
Applied Mathematics	Medical Imaging
Biology	Metallurgy
Biochemistry	Microbiology Immunology
Biomedical Engineering	Molecular, Cell & Development
Botany	Biology
Chemistry	Neuroscience and Human
Civil Engineering	Development
Clinical Laboratory Science	Nuclear Physics
Communicative Disorders	Nursing
Computer Science	Oceanography
Electrical Engineering	Physics
Environmental Science/Engineering	Psychology
Geological Science	Public Health
Industrial Technology	Toxicology
Informational Systems	Zoology

Source: Regional STEM survey 2007

Table 3.

M7 Counties

The seven counties of southeastern Wisconsin that comprise the M7 region are: Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha. Of the seven counties, the majority of survey respondents, 74%, reside in Milwaukee County (see Table 2).

Degree Attainment

As indicated in Figure 4, 55% of respondents obtained their degrees outside of the M7 region, and approximately 74% earned degrees in STEM or STEM-related disciplines (see Figure 5). Table 3 provides a list of the STEM and STEM-related disciplines in which respondents obtained their degrees, with mathematics, engineering, chemistry, physics, and nursing being among the most frequently reported disciplines. Moreover, respondents earned degrees from a variety of institutions, both within and outside of Wisconsin. Table 4 provides a list of the in-state and out- of-state institutions from which they received these degrees.

Attraction to STEM

Respondents explained many factors that initially attracted them to their respective STEM disciplines. The most salient among them were: (a) a general interest in math and science that was cultivated in junior high school and high school, (b) curiosity about how technology works, (c) a vast array of career opportunities, (d) the opportunity to provide a public service and help others, and (e) the ability to engage in problem solving and hands-on activities that provide an immediate sense of gratification. Regardless of age, gender, or racial/ethnic background, nearly all respondents shared a significant interest in STEM or STEM-related subjects, with computer science and mathematics ranking among the most popular subjects. As one respondent shared, "I was interested in STEM from early on. I've always enjoyed computers and mathematics since I was in elementary school." Another respondent shared, "Since the age of nine, I have excelled at science and math. My interest was nurtured

Wisconsin Awarded STEM Degrees vs. Other Institutions

Wisconsin	Others	
Carroll College	Univ. of Iowa	Univ. of British
Cardinal Stritch Unvi.	Northern Illinois Univ.	Columbia
Medical College of	Saint Louis Univ.	Univ. of Basel
Wisconsin	Univ. of South Florida	Univ. of Illinois Urbana
Milwaukee Area Technical	Univ. of Oklahoma	Bombay Univ.
College	Oregon State Univ.	Univ. of Missouri
University of Wisconsin	Northern Michigan Univ.	Lamar Univ.
Eau Claire	Univ. of Arizona	North Carolina State
LaCrosse	Washington Univ.	Dartmouth College
Madison	Haverford College	Rutgers Univ.
Milwaukee	Indiana Univ.	UCLA
Osh Kosh	Ohio State Univ.	McMaster Univ.
Parkside	Northwestern Univ.	Univ. of Maryland
Platteville	Cornell Univ.	Illinois State Univ.
Stevens Point	John Hopkins Univ.	Univ. of North Dakota
Stout	Central Michigan Univ.	Univ. of Alabama
Gateway Technical College	Branders Univ.	Univ. of Tennessee
Mount Mary College	Virginia Tech	Duke Univ.
	Purdue Univ.	Texas Tech.
	Arizona State Univ.	Xavier Univ.
	Stanford Univ.	Cincinnati
	Valparaiso Univ.	SUNY Buffalo
	Univ. of Pittsburg	George Washington
	Illinois Institute of	Clark Univ.
	Technology	Brown Univ.
	UC- San Diego	Oxford Univ.
	MIT	Loras College
	UC-Berkeley	Rice Univ.
	Univ. of Minnesota	Columbia Univ.
	Michigan State Univ.	Mt. Holyoke College
	College of Wooster	UC-Santa Barbara
	Loyola Univ.	Case Western Reserve
	Chicago	Tulane Univ.
	University of Detroit	Univ. of Wyoming
	USC	Univ. of Rochester

Table 4.

by my parents and teachers throughout school, but especially in high school."

Many respondents also described their interests as being related to problem solving and their deep-rooted desires to understand and make sense of the changing world around them. In fact, the desire to know "how something works," especially with regard to computers, was the most common thread across all respondent comments. As one respondent stated, "I have always had a great interest in how things work and how they are built. As a child, I dismantled my toys and put them back together." This respondent was not alone in terms of his sentiment, as another individual offered the following statement:

> I like problem solving, and problem solving with computers seemed particularly attractive. That was coupled with my desire to participate in a profession that contributes to the public good and provides an interesting variety of job options in a multitude of environments.

In addition to their general curiosity with regard to "how things work" as well as their drive to be socially productive, respondents additionally spoke to the immediate gratification that resulted from hands-on work in STEM and STEM-related disciplines. For many, their initial attraction to STEM fields was triggered by the realization of their abilities to apply math and science to practical issues that affect their communities.

STEM Organizations/Programming: Strengths and Weaknesses

When asked to comment on existing relationships among STEM organizations in the M7 region, only 43% of respondents were knowledgeable about these efforts (see Figure 6). The general consensus among those aware of these relationships was that they were cooperative and substantive in nature. Specifically noted was the strength of the connections among the Milwaukee Public School (MPS) system, Wisconsin Technical College system, other higher education institutions in the M7 region, and industry affiliates. One respondent shared, "MPS has been developing relationships for quite some time with business and higher education to improve the educational opportunities in STEM for K–12 students. The partnerships are deep and meaningful."

The M7 region maintains a commitment to providing educational opportunities in STEM for students throughout the pipeline. A shining example of this commitment, as indicated by many of the respondents, is Project Lead the Way. Other mentioned programs included Upward Bound, INROADS/Wisconsin, and the Minority Engineering Program at Marquette University and the University of Wisconsin–Milwaukee, as well as other articulation agreements between the Wisconsin Technical Colleges and postsecondary institutions in the M7 region. Programs like Project Lead the Way are successful because they are offered at the middle school and high school levels and connect K–12 schooling with higher and continuing education programs in the region. These programs continue to receive support from STEM organizations within the region such as the Society of Hispanic Engineering Professionals (SHEP), the National Society of Black Engineers (NSBE), and the Society of Women in Engineering (SWE). With such well- established programs, organizations, and STEM partnerships, the M7 region has a strong STEM infrastructure upon which it can build and increase educational opportunities for STEM students.

Weakness of STEM Organizations and Programming

Although the M7 region maintains a strong STEM network, there is minimal evidence to show that collaboration among STEM organizations is prevalent, with regard to nonpartnership arrangements in particular. Indeed, communication is often nonexistent within and among the M7 region's STEM organizations. As noted by several respondents, communication and transparency among these STEM organizations are integral to the region's efforts to position itself as a critical industry location. According to one respondent, "The relationships between the organizations could be better. There needs to be better coordination." Another respondent offered the following opinion, stating, "I believe that there are strong partnerships, but the community has tended to ignore partnerships already in place and prefers to reinvent the wheel." Such lack of communication among the M7 region's STEM organizations is a major weakness and may prove to be a fatal flaw in its infrastructure. As one respondent aptly stated, "We must begin to see collaboration, which is the key to truly breaking out of the box to lead in providing an innovative, leadership workforce to enhance the quality of life in the M7 region."

As previously mentioned, there are several STEM program initiatives in place to increase the number of STEM students and graduates. Respondents reported that these initiatives and programs, by and large, have made gains toward increasing the number of students in the STEM pipeline. Of the 49% of respondents who were aware of existing STEM programs efforts in the M7 region (see Figure 7), approximately 67% indicated that these initiatives are efficient in form and capacity (see Figure 8).

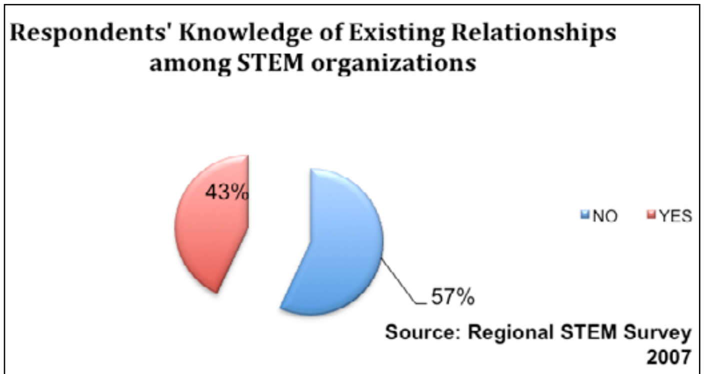

Figure 6.

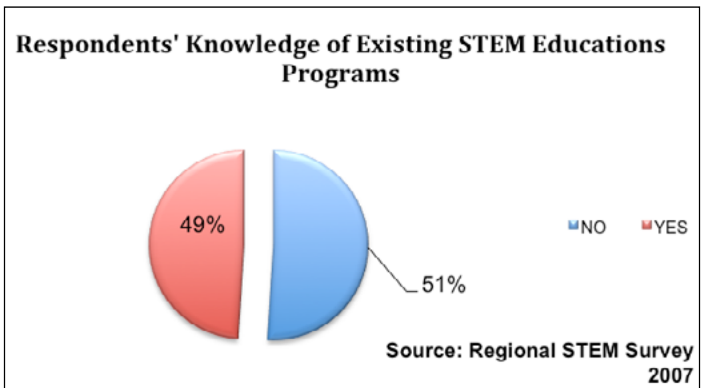

Figure 7.

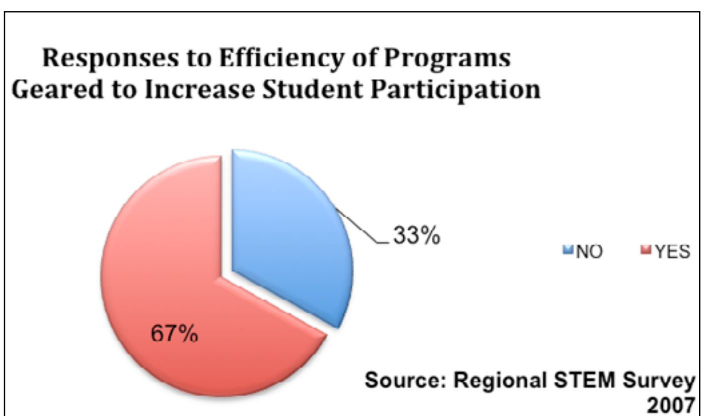

Figure 8.

Strength of STEM Organizations and Programming

It would seem, then, that the M7's STEM programs have proven beneficial. Much like the existing relationships among STEM organizations, there is a small but strong and established contingency of STEM programs already in place.

Weakness of STEM Organizations and Programming

In general, respondents felt that the size and scope of these STEM programs were major weaknesses and therefore needed to be expanded and enhanced. In turn, they provided a number of suggestions to help sustain and increase progress with regard to STEM recruitment and retention of students and graduates in the M7 region. The suggestions are as follows: (a) expand Project Lead the Way and other engineering education programs, (b) integrate STEM subjects across the curriculum at K–12 levels, (c) incorporate industry-supported, work-based programs and youth apprenticeships, (d) offer more competitive graduate school packages to STEM students of color that include built-in incentive packages for these students to remain in the M7 region upon earning their degrees, (e) offer tax breaks to STEM and development/research firms, (f) create annual incentive packages for firms that commit to hiring a specific number of STEM professionals and/or STEM students of color, and (g) develop merit scholarships for top high school students who express interest in pursuing STEM degrees at an M7 institution.

Respondents also recommended that the M7 region should improve its STEM recruitment and retention efforts. Although there is a substantial number of STEM program in place, they are small in scale and scope and are narrowly defined as academic and industry programs. As such, they exclude other potential mechanisms that can reach out to larger audiences—parental involvement, for example—which existing programs like Project Lead the Way do not emphasize.

In addition, leadership of the M7 region's STEM programs is somewhat disjointed, as described by many of the respondents. Participants cited more opportunities for collaboration and communication among different educational entities, especially at the K–12 level, as one method for improving STEM educational and programming leadership. One respondent specifically stated, "Assign a coordinator who will put together a collaboration or council of STEM organizations that will work together to ensure that students at all grade levels and precollege institutions are STEM-ready."

Threats and Opportunities for Improvement

Opportunity for Improvement

The M7 region is poised to become a major area of STEM growth across large metropolitan areas across the United States. There are job opportunities for STEM professionals in addition to other accommodations, such as housing and educational opportunities. In addition, the M7 region possesses a large public research institution in the University of Wisconsin– Milwaukee and a medium-sized private institution in Marquette University, both of which possess great potential to conduct advanced STEM research and attract high-profile technology and development firms to the region. With its geographic proximity to other large metropolitan areas, it stands as a desirable place to live and grow as a STEM professional. By capitalizing on geography, marketing the M7 region as an urban hub for young professionals, especially professionals of color, highlighting key financial opportunities for investment and entrepreneurial growth, and devoting more resources to the development of the aforementioned universities as world-class research centers, the M7 region can nationally compete with other large metropolitan areas where STEM professionals work.

Threats that Impede Improvement

The M7 region's cost of living as affected by high tax rates, STEM salaries that rank below the national average, and a lack of racial and ethnic diversity with regard to STEM jobs, might very well make it unattractive to students and professionals. As respondents unfavorably compared Milwaukee to other major metropolitan areas along the east and west coasts with regard to STEM salaries, it would appear as if the M7 region is a non-competitor in this arena. Unless STEM salaries are increased to take higher tax rates into account and unless STEM jobs are diversified, the M7 region will be unable to attract and retain qualified and talented STEM students and professionals.

Furthermore, the M7 region does not have a vibrant community of young STEM professionals of color. In fact, respondents indicated that there is a severe lack of representation and that southeastern Wisconsin is continually losing pools of highly qualified, young STEM professionals and students of color to historically Black colleges and universities (HBCUs) in the southeastern region of the country. While the latter universities have reported steady increases among STEM alumni of color who elect to stay in surrounding areas upon receipt of their STEM degrees, the M7 region has reported steady decreases.

Opportunity for Improvement

The M7 region is not alone in its endeavors to attract and retain more STEM students and professionals of color. These goals are national priorities, and federal agencies and private entities are committing millions of dollars toward developing a pool of STEM professionals of color across the country. As such, the M7 region has a unique opportunity to receive earmarked funds that are expressly intended to assist in this endeavor. By creating STEM pipeline programs that tap directly into Wisconsin's talent pools—and by appealing to students attending HBCUs who complete summer research and/or intern programs at the Medical College of Wisconsin, University of Wisconsin–Milwaukee, and other institutions—the M7 region can drastically increase the number of STEM professionals and students of color. This effort, of course, demands a concerted effort to recruit cohorts of students from institutions that produce highly qualified STEM students of color. It is important to note that there are non-HBCUs with high concentrations of STEM students of color that might provide the M7 region with an increased steady flow of aspiring STEM professionals of color as well.

Threats that Impede Improvement

Diversity is an important component of all healthy living, learning, and working environments, and this statement certainly applies to the M7 region. Failure to increase numbers of STEM students and professionals of color by actively recruiting and seeking such individuals will result in a gradual reduction of STEM professionals in region. Furthermore, many respondents developed a deep desire to explore STEM subjects as early as junior high school and high school. Grades 8–10 seem to be of particular importance, as most respondents identified these grade levels as times when they developed definitive plans to study STEM or its disciplines at the postsecondary level. Indeed, such interests may have, in fact, influenced these individuals' decisions to pursue postsecondary degrees.

Opportunity for Improvement

What is especially encouraging about this finding is that educators, researchers, and policymakers now know that early exposure is essential in order to develop and cultivate interest in STEM disciplines with regard to a student's educational career. By targeting elementary schools in the M7 region and affording students opportunities to explore STEM subjects in directed study classes, the number of young Wisconsinites who pursue careers in STEM or STEM-related disciplines could drastically increase over the course of the next 10 years. This surge could, in turn, create a steady flow of STEM professionals in the M7 region and in Wisconsin on the whole.

Threat that Impedes Improvement

Failing to develop and cultivate interest in STEM disciplines in grades 8–10 may result in the further loss of STEM talent. In addition, the absence of an incentive package to study these disciplines for high school or college credit may hurt general interest in STEM among students, thus reducing the number of potential STEM professionals.

In addition to encouraging "brain gain," the M7 region must also prevent "brain drain." In recent years, the issue of "brain drain" has become a priority among Wisconsin policymakers and employers; that is those who are educated in Wisconsin leave the state and provide other entities with their Wisconsin-attained scientific and technical talents. The state's economy is increasingly becoming a knowledge-driven one, and the STEM industry is no exception. In this particular instance, STEM knowledge is crucial to revitalizing the M7 business community. As previously mentioned then, the M7 region must identify desirable features that make it an attractive and amenable place to live and work for STEM students and professionals.

Opportunity for Improvement

One of the M7's greatest assets in the reduction of "brain drain" is its proximity to that which is familiar to Wisconsin STEM students and graduates by way of family relations, friends, and the quality of life. When asked why they elected to stay and work in the M7 region, many respondents indicated strong family and social ties within the area as a primary attraction, registering high quality of life and living as a secondary attraction. One by one, respondents gave heartfelt accounts of how important their families are to them. As one respondent shared, "My family is here. I stayed here mostly for family reasons. I stayed because of the close proximity, job availability, and the quality of life." This is just one comment among many that stresses the importance of family and maintaining and ties to close friends and loved ones.

The M7 region has a special opportunity unique to its geographic location to reinvent itself as "a place to call home" for new STEM recruits and to become a sustainable and likable setting for current residents. These words, "sustainable" and "likable," are used to appeal to STEM professionals and students who both have participated in and are currently undergoing the "M7 Experience." These individuals, therefore, are very familiar with the living conditions and high quality of life in the area as well as its proximity to other major cities.

Threats that Impede Improvement

The M7 region must emphasize retention as much as recruitment. Brain drain is as much of a concern as brain gain; equal emphasis must be placed on both. Should the M7 region fail to appeal and cater to existing STEM professionals and students, it will surely falter in its core efforts to revitalize the region and make it more STEM friendly.

M7 Stem Recommendations

This article consequently offers seven recommendations for improving the STEM workforce in the M7 region, organized into two categories: foundational efforts and unique opportunities. Foundational efforts constitute recommendations that are not likely to be viewed as new contributions regarding STEM discourse in the M7 region yet remain critical to establishing appropriate baseline efforts in order to move forward with proposed initiatives. Unique opportunities, conversely, are recommendations that emerge from data collection and analyses that, if implemented, would likely position the M7 region as a national center for STEM education and workforce development.

Foundational Efforts

Recommendation one: Increasing the number of underrepresented groups. The M7 region should take specific steps to increase the participation of women and people of color in STEM within the region. It affects the area insofar as it has large populations of color that could very well be STEM participants if provided with the proper incentives to pursue such careers.

By leveraging existing institutional strengths in this region, appropriate steps could be taken to remedy concerns of underrepresentation. For example, Marquette University produces large numbers of female engineers, especially in biomedical engineering, according to the October 2007 issue of ASEE PRISM Magazine (ASEE, 2007). These current and former students could potentially be strong advocates for recruiting underrepresented groups into engineering fields. Establishing STEM-based mentoring and scholarship programs for women and people of color at all levels could be carried out as a logical extension of current efforts. It is an effort that should include industry players as well for the sake of offering internships, shadow and employee days, and other programs to underrepresented populations.

Recommendation two: Recruiting from outside the M7 region. Recruiting from outside the M7 region is a key component to increasing the STEM-related workforce as well. For instance, in the November 2, 2007 Milwaukee Journal Sentinel (2007), there was an editorial on "Engineering Education," which stated:

> Job openings requiring expertise in science, technology, engineering and mathematics were expected to increase by 18.3% through 2014 in the state, compared with 11.5% for all other occupations, according to a February report by the Center on Education and Work at UW–Madison. Yet only 21% of the degrees awarded by the UW System and technical colleges focused on the fast-growing science, technology and engineering fields, the report states. And M7 data shows that the Milwaukee region has a smaller share of engineers, computer technicians and scientists than other faster-growing regions like the Twin Cities and Charlotte, N.C. (p. 19).

Such a goal of recruiting outside of the M7 region can be accomplished if STEM educators and employers attend job fairs at institutions outside the region. One approach would be to recruit from minority-serving institutions in the South and Southeast regions of the country. It is essential that these recruitment efforts include people of color to create a climate of familiarity during the recruitment visit. It is also important that recruiters promote what the M7 region has to offer prospective employees, both at work and within the community.

Recommendation three: Starting as early as possible. As previously mentioned, STEM education needs to start as early as possible, for children must be exposed to STEM skills during their initial years of formal education. This approach could be leveraged in the M7 region by establishing a STEM culture for young children by training non-STEM preschool and K–6 teachers on how best to foster such thinking at early ages. For example, Dr. Jeannette Wing talks about computational thinking (the method of solving problems using computer science techniques as it is a fundamental skill for everyone) and the benefits of such thought processing (Wing, 2006). Computational thinking should be integrated into STEM thinking, and these processes can be fostered at early stages of children's educational training by encouraging their innate curiosity.

Unique Opportunities

Recommendation one: Strengthening inter-STEM organizational relationships. The inventory database shows that there could be better balance between the programs across education and sector levels in order to foster a STEM program pipeline within the region. A decentralized set of STEM programs exist from K–16 and beyond, yet no central entity has knowledge of these specific activities and initiatives for all the programs and their sponsors. As such, no evidence of coordinated leadership for STEM programming in the M7 region exists.

Accordingly, it is recommended that the M7 region establish a STEM Federation that provides coordinated leadership for all pertinent programming. As a centralized incubator for both STEM innovation and professional guidance, the STEM Federation would be an annual conference where all STEM organizations and programs meet to share information. In turn, the organization would use this information to document all the programs in the Marquette University–Milwaukee Area Workforce Investment Board STEM Inventory Database. Ideally comprised of industry representatives, (e.g., GE and Johnson Controls), educational institutions (e.g., Marquette, UW–Milwaukee, and MPS), and existing boards and programs (e.g. Milwaukee Area Workforce Investment Board), the federation's mission would be to maintain and facilitate knowledge- sharing between STEM organizations and projects within the region.

Recommendation two: Marketing STEM programs. The M7 region needs to market STEM programs to women and people of color, both traditionally underrepresented in STEM professions. One method of doing so is to use the STEM Federation and/or industry and philanthropic organizations to establish a STEM marketing campaign. Resources such as public television can be used to influence students' perceptions and understanding of STEM. The underlying goal of these programs, then, is to bring back the "coolness" of STEM. Innovations such as "edutainment" can be used inside and outside the classroom to help reinforce STEM subjects. Some examples of these technologies are the African-American Distributed Multiple Learning Styles System (AADMLSS), Culturally Situated Design Tools, and MindRap.

Recommendation three: Prioritizing STEM education. The nation also suffers from a shortage of STEM teachers in K–12. There is a need in the M7 region and the United States on the whole to address the insufficient number of STEM teachers in K–12. The National Science Foundation has a program called the Graduate Teaching Fellows in K–12 Education (GK-12). The program offers funding to graduate students in NSF-supported STEM disciplines for the sake of acquiring communication, teaching, collaboration, and team-building skills that will prove useful for their scientific careers. By interacting with teachers and students in K–12 settings and with other STEM graduate students and faculty, these fellows enrich STEM education in elementary school, junior high school, and high school while simultaneously advancing their own educational and professional development (NSF, 2011).

Therefore, it is recommended that the M7 region create a similar program to fill vacant STEM teacher positions. It is a program that can be realized by educators in the region by: (a) applying for an NSF GK-12 grant, (b) collaborating with the Center for Mathematics and Science Education Research (CMSER) at UW–Milwaukee, and (c) working with the Milwaukee Mathematics Partnership.

A K–12 STEM teacher's salary is approximately $30,000-40,000 per year, plus benefits. It is recommended that these funds be used to create endowed or distinguished professorships at the universities within the M7 region. Professors would receive an annual bonus for their contributions, and their parent department and/or college would receive funds to release the professors from teaching or reduce their teaching loads. In return, the professors and their graduate students would teach STEM courses in area schools. A program of this nature could build a relationship between K–12 and higher education institutions in the M7 region, one constructed around STEM. An additional benefit of this relationship is that this program will increase the likelihood of K–12 students staying in the region, enrolling in area universities, and majoring in STEM-related fields.

Recommendation four: Creating a research institute. In an effort to connect the corporate STEM community with the academic community, this article advocates for the creation of a Wisconsin Research Institute for the Theory and Practice of STEM Entrepreneurial Wealth Creation. This Institute would be modeled after the IC2 Institute at the University of Texas at Austin, albeit with a few adjustments. The Wisconsin Institute would be housed at Marquette University or at UW–Milwaukee and would create entrepreneurship programs with an emphasis in STEM. For example, the authors recommend the creation of a Master of Science degree in Science and Technology Commercialization. The program could additionally include incentives for graduates to create businesses within the M7 region. Endowed faculty fellows would be participating in the Wisconsin Institute as well.

As the vision and purpose of the institute is to create more STEM research, practice, and policies within the M7 region, it would benefit from interfacing with the Center for Advanced Technology and Innovation (CATI). CATI represents a new model for technology entrepreneurship, one that crosses campuses and programs, to provide training for a wide range of populations. Formed to promote business development, workforce development, and technology innovation in southeast Wisconsin, CATI seeks to fulfill these goals by engaging in a three-pronged approach: (a) a technology incubation facility where new and developing firms can economically develop and market new technology, products, and services (b) a technology transfer office to help leverage research and development activities at local and regional educational institutions, businesses, and industries, and (c) an education program integrated with local colleges, universities, and school districts to provide project-based learning opportunities to students from high schools, colleges, graduate schools, and entrepreneurship courses for a wide range of audiences, including underemployed and unemployed individuals (Arion, Secor, & Wagner, 2003).

Conclusion

The findings of this study parallel national trends in the lagging growth of individuals earning STEM-related degrees as compared to the growth of science and engineering sectors within the U.S. economy. Likewise, a key component in addressing the state of STEM economic development within the M7 region is directly related to education or the lack thereof. This concern echoes other economic studies that necessitate interventions starting with K–12 education systems, particularly grades 8–10, as they relate to increased exposure and development in the areas of science, technology, engineering, and mathematics.

This case study required a data collection process which, at its conclusion, produced a fully searchable database of STEM programs. To our knowledge, this is the only STEM program database of its kind within the country. The functionality of this database enables users to quickly and efficiently assess and reassess the state of STEM affairs within the M7 region. It is fluid and dynamic, able to be updated to reflect changes within STEM programs and, ultimately, to chart progress within the field.

The M7 region, particularly Milwaukee County, has the propensity to become a major center for cultural arts, advanced STEM-related research, and high-quality education programs. By capitalizing on geographic location, it can market itself as an urban nexus for young professionals and students of color in particular. In an effort to compete with other metropolitan areas that embrace the STEM disciplines, the M7 region can identify key financial opportunities for investment and entrepreneurial growth and devote more resources to the cultivation and development of the region as a STEM corridor.

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