Illuminating the Computing Pathway for Women in Mississippi

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Abstract

The NSF INCLUDES Mississippi Alliance for Women in Computing (MSAWC) strives to: generate interest and participation of women in computing; improve recruitment and retention rates of women in undergraduate computing majors; and help post-secondary women make a transition to the computing workforce. Activities designed to engage girls and young women with computing, emphasizing computational thinking and cybersecurity knowledge and awareness, and to illuminate a pathway forward are hosted and facilitated through Alliance partnerships.

The authors will describe a project-based approach to facilitating learning among K-12 students. By engaging students at an early age, we believe we can promote the development of self-efficacy in computing before adolescent opinions are formed that may discourage girls from seeking curricular or co-curricular experiences in computing. Further, we will describe how the MSAWC is illuminating the path for girls and women in the state, to engage them with computing and to influence their persistence on the computing pathway through college and into the workforce, using collective impact strategy.

Introduction

The Mississippi Alliance for Women in Computing (MSAWC) adopts the strategies of Doerschuk et.al. intentionally growing existing programs and developing new ones across the state in order to successfully recruit, retain, and transition young women into the computing workforce [1]. MSAWC is refining scalable pathways models that focus on engaging women and encouraging persistence on a computing pathway in Mississippi (MS) with a strategy of expansion to a Southern Alliance for Computing Education (SACE) that will broaden participation to all under-served and under-represented students in the southern region of the United States (US) [2].

MSAWC has three major objectives, to: 1) attract women and women of color to computing; 2) improve retention rates of women in undergraduate computing majors, and 3) help postsecondary women make the transition to the computing workforce. With mixed method study [3], the primary research question that guides this work is: What are the factors that influence and motivate female students and female African American students in MS to enroll and persist in an undergraduate engineering- or science-based computing major? Analysis is expected to reveal the experiences and stakeholders that impact their decisions to enroll in a computing major and persist into the workforce.

Background

With global competitiveness and homeland security driving the need to increase United States participation in the science, technology, engineering and mathematics (STEM) workforce [4]. In 2013, the National Center for Women and Information Technology (NCWIT) reported that only 26% of jobs in computing were held by women; African American women represented only 3% of the computing workforce [5]. This reflects the need for accessible co-curricular programming in the southern region of the United States (US), particularly for females and racial

minorities who are less likely to visualize themselves as a computing professional [6]. Research indicates that young women are underexposed to technology in their youth resulting in reduced knowledge of and comfort with computing and demotivation to enter computer science (CS) fields. This is partially due to socioeconomics and an underlying belief that girls lack the ability to be 'technical' [7].

Recruitment and retention are both important areas of focus in addressing the gender gap, and increasing the number of women on STEM pathways will provide a larger pool for retention efforts [4]. With studies revealing that an important predictor for undergraduate major choice is 'interest', it is important to provide curricular and co-curricular activities for women in K-12 through which they may develop an interest in computing [8].

Public school enrollment in the state of MS for the 2017-2018 school year in grades Pre-K to 12 is 477,633 as reported by the Mississippi Department of Education (MDE). 48.93% of these students are female with 48% also reporting as African American [9]. 70% of the total public school enrollment receives free or reduced meals in school [10]. Mississippi State University (MSU) is working to address the problem of rural access to co-curricular programs [11] in the state of MS. MSAWC seeks to engage girls and women with computing through K-12 outreach programs for students and teachers.

Danielak et.al. assert that retention and course improvement are overlapping opportunities. Student input on their beliefs and attitudes in the context of course content [12] must be considered. Co-curricular programs can address the lack of sense of belonging that women often feel in engineering and computer science courses and majors [13, 14]. Through mentoring and tutoring services for female students, MSAWC is addressing additional factors that researchers reveal have an impact on retention, including advising and the difficulty of the curriculum.

Collective Alliance

MSAWC uses a collective impact strategy to create opportunities in the state, with a goal of scaling to the southeast region. Collective impact includes five conditions:

1. A common agenda,
2. Shared measurement,
3. Mutually reinforcing activities,
4. Continuous communication,
5. A contributing backbone organization. [15]

To recruit, retain, and transition young women, and particularly women of color, into the computing workforce, MSAWC is modeled after similar, proven broadening participation in computing (BPC) collective impact approaches. Specifically, four strategies with proven success, listed in Table 1 [16] provide a foundation for MSAWC activities.

Table 1. BPC Collective Alliance Approaches [16]

Proven Approach	**Description**
Reforming statewide systems	Develop a common framework that focused on students and educational systems on various levels of the educational pathway.
Focusing on undergraduates	Provide introductory computing classes for students, with an emphasis on relevancy, in addition to professional development opportunities. Provide near-peer mentoring, partnering

	undergraduates with K-12 students, to "motivate both to reach their personal best in computing."
Connecting unlike institutions/Creating new partnership models	Develop productive relationships between diverse types of institutions.
Creating national/interlocking networks	Provide opportunities to engage students and educators at all levels to develop professional skills and knowledge.

Activities in year one that support these collective alliance approaches are described in the Activities section below.

Activities

Aspirations in Computing

An NCWIT Academic Alliance member since 2012, MSU hosts the MS Affiliate of the Aspirations in Computing (AiC) award program. MS Aspirations winners are awarded a $500 scholarship that may be used at MSU as a computer science, software engineering, or computer engineering major. MSAWC is pursuing private sector funding for scholarships that can be used by AiC winners at any MS institution of higher learning. MSU works with winners of the award to offer K12 outreach opportunities. AiC winners are encouraged to apply for funding through NCWIT's AspireIT program to offer computing outreach opportunities for girls in their communities [17]. Due to efforts of MSAWC partners, the growth of the AiC program in MS has been substantial. In 2013, there were four AiC applicants. In 2016, 29 girls applied for the award and 58 applied in 2017. The trajectory of this pathway entry point is shown in Figure 1.

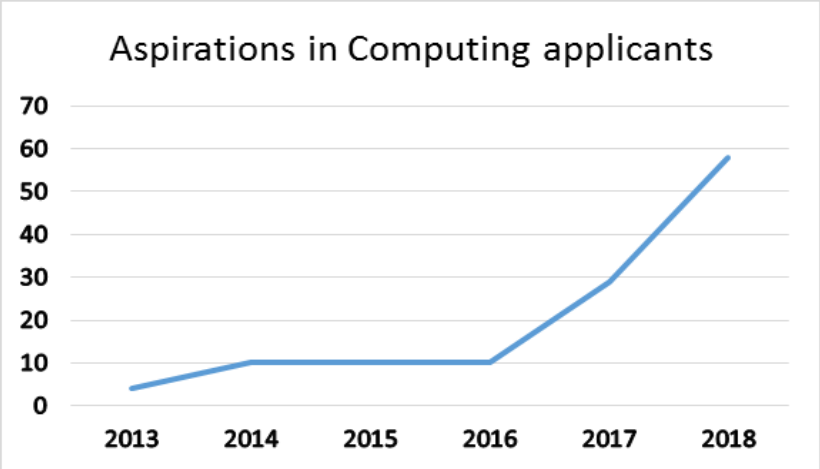

Figure 1. Aspirations in Computing Applicants

Student Co-Curricular Outreach Programs

With the knowledge that computational thinking is used to design solutions to problems in a variety of domains, the Computer Science and Engineering (CSE) department at MSU hosted an interdisciplinary summer computing outreach experience for middle and high school girls in

2014 through the Bulldog Bytes computing outreach program [18]. In the summer of 2016, the expansion of Bulldog Bytes from residential camp offerings to a summer day camp for elementary aged girls was piloted in Columbus MS. With the success of that pilot, and in support of a strategy to take co-curricular computing engagement opportunities to girls in their communities, two elementary girls day camps were offered in 2017. One was held in West Point and one in Columbus, both rural communities reporting high percentages of children under 18 living in poverty at 37.7% and 30.9% respectively [10]. Forty girls, between 2nd and 6th grades, were introduced to computer programming as well as cybersecurity concepts with a heavy emphasis on the GenCyber program's ten Cybersecurity First Principles [19]. Hands-on, project-based learning involved applying the First Principles to activities that also strengthened their team work and problem solving skills. The First Principles are described in Table 2.

Table 2. Cybersecurity First Principles [19]

Principle	Description
Minimization	Decreasing the number of ways that software can be exploited.
Simplicity	Keeping things simple so that problems are easier to identify and fix.
Abstraction	Summarizing in a way that is easy to understand.
Information Hiding	Preventing users from seeing information that they do not need to see.
Least Privilege	Limitations on what access users have to resources and how they can use the resources.
Modularity	Each module should have its own function and be able to be inserted or removed.
Layering	Multiple layers of defense for protection.
Resource Encapsulation	Resources should be separated and used only as intended.
Process Isolation	Keeping processes separate prevents the failure of one process from negatively impacting another process.
Domain Separation	Separating areas where resources are located prevents accidents and loss of data, keeping information worlds from colliding.

In addition to the elementary camp, 25 girls in middle and high school participated in a residential computing camp on the university campus in 2017. As with the elementary camps, robots were used to emphasize cybersecurity principles and to engage the girls with computational thinking. To ease the transition for young women from high school to college, a summer bridge program was hosted for females entering engineering or science-based computing majors. Some of those participants are participating in the first MSAWC living learning community during the 2017-2018 academic year through which they have a mentoring and tutoring service available, staffed by undergraduate women majoring in computer science.

Other initiatives across the state have offered engagement activities to engage young women with computing. These include, but are not limited to, the following in 2017:

- At the University of Southern Mississippi, the iD8 initiative encourages greater diversity in CS with a variety of programs: an app development hackathon for African-American girls, Gulf Coast ADVANCE (NSF #1447239), and a Women in Science and Engineering (WISE) annual conference and monthly activities [20].

- MSAWC partners provided interactive stations for approximately 6600 MS 8th graders at the Pathways2Possiblities [21] career exhibition in Biloxi MS.
- An MSU undergraduate delivered a Saturday workshop for girls through the ProjectCSGirls [22] program.
- Tougaloo College hosted a multi-weekend program to teach computer programming to elementary aged girls.
- The Center for Social Entrepreneurship hosted a summer day camp for elementary girls and their female caregivers in Jackson MS.
- MSU hosted a computer programming workshop for girls in 4th – 12 grades, sponsored by Delta Sigma Theta Sorority.

K12 Teacher Professional Development

Since 2016, the CSE and the MSU Curriculum, Instruction and Special Education (CISE) departments have partnered to offer GenCyber workshops for in-service teachers across all disciplines to learn and bring computing, cybersecurity, and computational thinking into their classrooms. These educational opportunities have the following goals: 1) increase cybersecurity knowledge and awareness, aligning with content standards, 2) promote pedagogical practice, such as grouping strategies, management techniques, questioning types, engaging students in productive struggle, and fostering classroom discourse to promote problem solving skill development, and 3) plan lessons which integrate cybersecurity concepts in teachers' classrooms bridging cross-curricular content.

Computational thinking is relevant across academic disciplines and has the potential to promote student interest in STEM pathways [23]. Female students in MS score as well as their male counterparts on content area assessments [24], however, they are vastly underrepresented in the computer and information science field [25]. Teachers can promote equity and access to computer science and technology in nonthreatening environments and build confidence by promoting the engagement of students in problem solving through technological relevant experiences. Through the CSE and CISE partnership efforts, middle and high school teachers representing a variety of disciplines (chemistry, mathematics, engineering, English language arts, special education, social studies, etc.) collaborate in their study of programming and cyber security principles. The teachers first engage as learners through productive struggle and problem solving. After primary content development, participating teachers collaborate to structure lesson plans for their classrooms integrating computational thinking. This cross-disciplinary approach mimics workforce expectations and is supported by prior work. That is, technology is not experienced in isolation from other facets of life, but rather it is integrated into our experiences [26].

Assessment data from the 2017 workshops yield insight into the teacher impact of introducing computer science through our model. Data were primarily quantitative including TPACK Self Reflections on content knowledge domains, TPACK Self-Assessment Surveys, and Cyber Principles Assessments [27]. These assessments were given pre- and post-workshop to 30 workshop participants. All participants were middle or high school teachers from varying disciplines.

Data gathered from the workshop experiences provide insights into the successes and challenges of the workshop design. The TPACK Self Reflection data indicates participants did perceive some TPACK growth during the workshop, with the least growth observed in the Content Knowledge domain, and the greatest growth in the TPACK domain. The second largest area of growth is the Pedagogical Knowledge domain, suggesting that a group of teachers representing a variety of disciplines benefited in their methods of practice through this experience.

The TPACK Self-Assessment Survey data included a 15% score increase from pre- to post-assessment, indicating a significant TPACK growth across themes. Five of the participants experienced scores which decreased, but provided notes indicating a clearer understanding of the descriptors at post-assessment. The greatest growth on this assessment was 24 points (44%), attained by two participants. This data suggests there is great potential for participants TPACK to increase across themes (curriculum, assessment, learning, teaching, and access).

The Cyber Principles Assessment provided documentation of growth with regard to the GenCyber Cybersecurity First Principles [19] that were a focus throughout the workshop. This growth is not surprising, given the amount of exploration and application dedicated to the principles throughout the week. It has been suggested that the principles be introduced in a pre-workshop format in the next iteration, which will allow more growth opportunity and a better distinction between superficial knowledge and more meaningful understanding of the principles. Further, participants were largely weak in fluency with connections of the principles to their classroom practice, suggesting that a greater amount of time should be spent on lesson development and collaboration focused on the principles within the represented content areas.

Based on outcomes of this summer professional development, CSE and CISE have also developed and offered a credit course offering, Integrating Computing and Cybersecurity in the Classroom, for undergraduate and graduate pre-service teachers, with an online option for in-service teachers. This integrated approach to computer science leverages the successes in closing the achievement gap in core content areas to address the computer self-efficacy and experience gap.

Partnering

Results from one year of support include the creation of a statewide alliance and the foundation for a broader regional alliance, SACE, as represented in Figure 2. MSAWC alliance partnerships, driven by the non-profit organization InnovateMS that facilitates technology-based economic development in the state, have provided leadership to the formation of a MS-wide collaborative effort, CodeMS, extending the goals of MSAWC to all underserved students in MS. Alliance partner leadership is driving the concept of a ‘Silicon South’, building a framework for SACE that will inform and enable the growth of a technically skilled workforce and technology industry in the southern region.

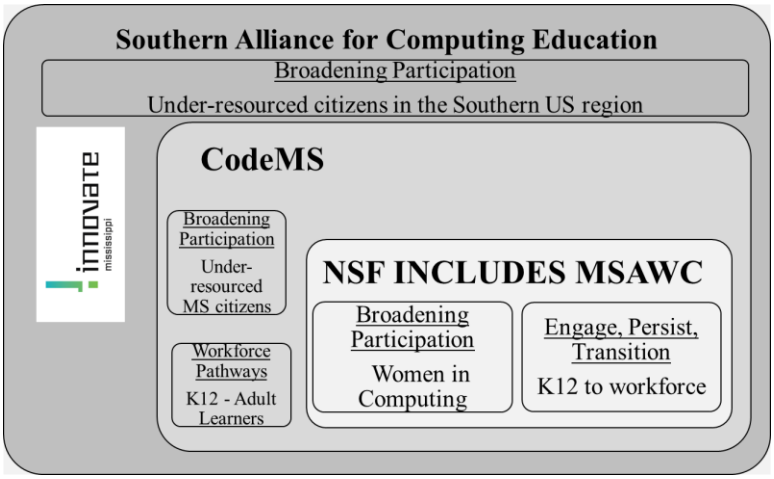

Figure 2. MSAWC Collective Alliance Evolutionary Strategy

The Study

Methods employed in Edzie's mixed method study [3] are used to study the primary research question: What are the factors that influence and motivate female students and female African American students in MS to enroll and persist in an undergraduate engineering- or science-based computing major? Through discriminant analysis, research questions are addressed with methods as shown in Table 3.

Table 3. Research Methods

Which pre-collegiate experiences influenced them to enroll? Data Source Demographic and background survey administered to women entering an undergraduate engineering- or science-based computing major at a university in MS	Outcome Variables Status as (a) a female undergraduate student with no involvement with MSAWC programming, (b) MSAWC activity participant, or (c) a MSAWC participant having graduated with a bachelor's degree in a STEM major Predictor Variables Pre-collegiate experiences
Which stakeholders influenced these girls in their decision-making process? Data Source Demographic and background survey administered to women entering an undergraduate engineering- or science-based computing major at a university in MS	Outcome Variables Status as (a) a female undergraduate student with no involvement with MSAWC programming, (b) MSAWC activity participant, or (c) a MSAWC participant having graduated with a bachelor's degree in a STEM major Predictor Variables Stakeholders
What programs are effective in impacting their persistence in the	Outcome Variables Status as (a) a female undergraduate student with no

major? Data Source Student surveys and student evaluations	involvement with MSAWC programming, (b) MSAWC activity participant, or (c) a MSAWC participant having graduated with a bachelor's degree in a STEM major Predictor Variables Programs

Year one data collection

Data collection was initiated to inform a longitudinal study of what factors influence and motivate female students and female African American students in MS to enroll and persist in an undergraduate computing major. Both a qualitative and quantitative method approach was taken, and two different surveys were used to gather data. The targeted groups consisted of females entering college in fall 2017 and enrolled in an introductory class (CSE 1002) required for new freshmen entering a CSE major, and participants in a 2017 summer bridge program for young women who planned to enter a computing major in the fall. Eleven female participants were enrolled in the CS course and 6 female participants were in the summer bridge program.

The itemized survey for the CSE 1002 female participants yielded a 100% response rate while the survey for the summer bridge participants yielded a 67% response rate. Variables such as the participants' gender, ethnicity, major, future computing major, and preferred method of learning were examined. Four of the summer bridge students were Black, not Hispanic or Latino, and two were Asian. One Asian, and three Black participants completed the survey. Figure 3 demonstrates the racial ethnicity of the female participants in CSE 1002.

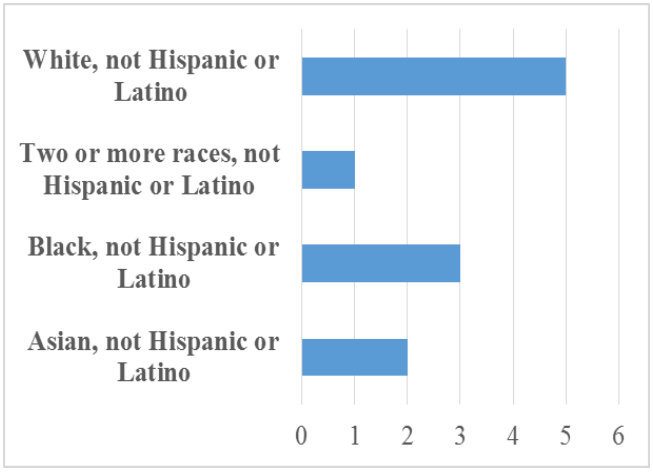

Figure 3. 2017 CSE 1002 Females and Racial Ethnicity

As a measure of what factors influenced and motivated the CSE 1002 participants to enroll and persist in an undergraduate engineering or science based computing major, variables such as: participation in any summer programs/extracurricular activity post high school, participation in a computing course in high school, support programs and participation in any inclusion programs during college were examined. Analysis indicated that only 30% of the participants, participated

in a summer program or extracurricular activity that involved computing before their freshmen semester and 45% of the participants took some type of computing course in high school.

To understand if support programs such as tutoring, mentoring or any other student support services offered at the current institution influenced the participants to persist in a computing major, the data analysis revealed that both tutoring and counseling services were the most influential in helping the participants persist. It was also found that 30% of the participants are currently members of different co-curricular groups that specifically served women, minorities, or students with disabilities. While examining factors that influenced the summer bridge participants, analysis revealed that summer program participation, student interest in technology, high school engineering courses, teachers and mentors were all influential in the participant's choice to select a computing major.

To inform the study of practices that strengthen retention, students were asked their preferred method of learning in the class, and were presented with seven alternatives: a) more practical work than theory, b) use of demos in class rather than slides, c) fewer tests and more assignments, d) fewer assignments and more tests, e) more group assignments, f) more individual assignments, and g) I am satisfied with current teaching methods. The participants were also given the option to write in their preferred method of learning/teaching. The results of data analysis revealed that the students preferred method of learning was from more practical work than theory (28%) and use of demos in class rather than slides (28%).

MSAWC Project Evaluation

The MSAWC project is evaluated externally through a contractual arrangement with the Office of Educational Innovation and Evaluation (OEIE) at Kansas State University. Highlights from the year one evaluation report [28] are included below.

> MSAWC made good progress on building the alliance as well as delivering activities and programs for young women. MSAWC gained 33 alliance members, as of summer 2017, by establishing partnerships with schools, communities, higher education institutions, nonprofit organizations, and industry representatives. MASAWC offered a variety of computing programs and activities for K-12 and college-aged young women, including summer camps and other outreach activities, the Summer Bridge, and the Living Learning Community, and has engaged members in these activities. Members reported that MSAWC is doing an effective job at incorporating the five conditions of Collective Impact into the project….MSAWC identified effective strategies that may be easily scalable beyond the state of Mississippi. These scalable strategies include holding outreach events in communities, engaging industry partners in outreach activities, creating a mentoring program, offering tutoring support, providing an interview <clothes> closet, and holding mock interviews. …MSAWC has already begun working toward sustainability of project activities by aligning with existing initiatives, establishing partnerships, and training others to provide outreach events, leveraging/seeking other funding sources for grant activities, and disseminating project efforts [28].

Supporting the BPC strategy of "productive relationships between diverse types of institutions" [15], MSAWC is comprised of a variety of stakeholders with evidence of those relationships

demonstrated through year one activities. With year one focused on relationship building, and leveraging existing and building new programs to engage girls and women on computing pathways, year two focus centers around strategically formalizing a broader Southern alliance, to ensure scalability and sustainability [2]. Tactical work for year two includes: 1) bringing new collaborators to the discussion, 2) identifying and documenting challenges and gaps in access to curricular and co-curricular computing education, 3) identifying best practices for engaging under-resourced citizens in computing from preschool to the workforce and developing plans to replicate those proven programs throughout the southern US, and 4) identifying common metrics that determine success across all collective activities.

Summary

Computing is an integral part of all disciplines, yet students often are unable to see the relevancy of computing to their life goals. An understanding of principles of cybersecurity is also critical to the safety of all citizens, and safe, responsible online behavior protects the larger community. Economic development is impacted by all of these issues, and economic growth is dependent on developing a work force with computing skills, with an attention to cybersecurity regardless of the industry domain. A longitudinal examination of the variables that affect self-efficacy in computing and persistence in CS education by gender, race, and socio-economic status will benefit intervention strategies.

Existing MSU relationships with InnovateMS, AccessComputing, NCWIT, Project Lead The Way, College Options Foundation, the National Security Agency's GenCyber program, and with other industry representatives, provide a promising collaborative to lead efforts to institutionalize a collective alliance backbone organization across the southern US. A broader consortium across southern states will provide a platform for developing a more diverse computing and technical workforce, with particular emphasis on rural southern communities.

To design a broader southern collective alliance, the following questions will be addressed by MSAWC key partners:

- What are research-based curricular and co-curricular programs that have been implemented in other states?
- What should a backbone organizational structure look like?
- How do we develop levels of sponsorship across industry that will sustain a backbone organization?
- Why type of on-ramp engagement should be established for Southern Alliance to expand proven practices?
- Beyond current relationships with NCWIT and AccessComputing, what other national backbone organizations supporting the goals of NSF INCLUDES should a Southern Alliance align with to inform a wider audience and to leverage best practices?

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References

[1] P. Doerschuk, J. Liu, and J. Mann, "INSPIRED broadening participation in computing: most successful strategies and lessons learned," in *2010 IEEE Frontiers in Education Conference (FIE)*, October 2010, Washington, D.C., pp. T2H–1–T2H–6.

[2] J. M. Waitzer, and R. Paul, "Scaling social impact: When everybody contributes, everybody wins," *Innovation: Technology, Governance, Globalization*, vol. 6, no.2, pp.143–155, Apr. 2011.

[3] R. L. Edzie, "Exploring the factors that influence and motivate female students to enroll and persist in collegiate STEM degree programs: A mixed methods study," Ph. D. dissertation, University of Nebrska, 2014.

[4] C. C. de Cohen and N. Deterding, "Widening the net: National estimates of gender disparities in engineering," *Journal of Engineering Education*, vol. 98, no. 3, pp. 211–226, Jul. 2009.

[5] "By the Numbers," 2014. [Online]. Available: http://www.ncwit.org/sites/default/files/resources/btn_02282014web.pdf. [Accessed Dec.10, 2017].

[6] K. Kelly, D. Dampier, and K. Carr, "Willing, able, and unwanted: High school girls potential selves in computing,"*Journal of Women and Minorities in Science and Engineering*, vol. 19, no. 1, pp. 67–85, 2013.

[7] M. (Mia) Ong, "The status of women of color in computer science," *Commun. ACM*, vol. 54, no. 7, p. 32, Jul. 2011.

[8] V. A. Haines, J. E. Wallace, and M. E. Cannon, "Exploring the gender gap in engineering: A re-specification and test of the hypothesis of cumulative advantages and disadvantages," *Journal of Engineering Education*, vol. 90, no. 4, pp. 677–684, Oct. 2001.

[9] "Mississippi Department of Education." [Online]. Available: http://reports.mde.k12.ms.us/data/. [Accessed Dec. 9, 2017].

[10] "Kids Count Data Center." [Online]. Available: http://datacenter.kidscount.org/. [Online]. [Accessed Dec. 9, 2017].

[11] J. A. Fredricks and S. D. Simpkins, "Promoting positive youth development through organized after-school activities: Taking a closer look at participation of ethnic minority youth," *Child Development Perspectives*, vol. 6, no. 3, pp. 280–287, Sep. 2012.

[12] B. A. Danielak, A. Gupta, and A. Elby, "The marginalized identities of sense-makers: reframing engineering student retention," in *2010 IEEE Frontiers in Education Conference (FIE)*, 2010, pp. S1H–1–S1H–6.

[13] R.M. Marra, K.A. Rodgers, D. Shen, and B. Bogue, "Women engineering students and self-efficacy: A multi-year, multi-institution study of women engineering student self-efficacy," *Journal of Engineering Education,* vol. 98, no.1, pp. 27-38, Jan. 2009.

[14] R. M. Marra, K. A. Rodgers, D. Shen, and B. Bogue, "Leaving Engineering: A Multi-Year Single Institution Study," *Journal of Engineering Education*, vol. 101, no. 1, pp. 6–27, Jan. 2012.

[15] J. Kania and Kramer, M. Kramer, "Collective impact," 2011. [Online]. Available: https://ssir.org/articles/entry/collective_impact. [Accessed Jan.21, 2018].

[16] D. Chubin and R. Johnson, "A program greater than the sum of its parts: the BPC Alliances," *Commun. ACM*, vol. 54, no. 3, pp. 35-37, Mar. 2011.

[17] S. B. Lee and R. Walker, "Engaging middle school girls in computing with a project-based summer experience," *ASEE Southeast Annual Conference*, 2014. [Online]. Available: http://se.asee.org/proceedings/ASEE2014/Papers2014/36.pdf. [Accessed Dec.7, 2017].

[18] S. B. Lee, S. Kastner, and R. Walker. (2015) Mending the Gap, Growing the Pipeline: Increasing Female Representation in Computing**,** Proceedings of the 2015 ASEE SE Annual Conference.

[19] B. R. Payne, T. Abegaz, and K. Antonia, "Planning and implementing a successful NSA-NSF GenCyber Summer Cyber Academy," *Journal of Cybersecurity Education, Research and Practice*, vol. 2016, no. 2, article 3. [Online]. Available: http://digitalcommons.kennesaw.edu/jcerp/vol2016/iss2/3. [Accessed Nov.7, 2017].

[20] J. Cwikla. 'Projects & Activities.' [Online]. Available: http://www.juliecwikla.com/projects/. [Accessed: 10-Feb-2018].

[21] 'Pathways2Possibilities.'[Online]. Available: https://www.pathways2possibilities.org/. [Accessed: 9-Dec-2017].

[22] ProjectCSGIRLS. [Online]. Available: http://www.projectcsgirls.com/. [Accessed: 09-Dec-2017].

[23] J. Ivy, S. Hollis, D. Franz, S. Lee, and D. Reese, "Exploring pathways to developing self-efficacy in new computer science teachers," *ASEE Zone II Conference*, 2017. [Online]. Avaiable: http://zone2.asee.org/sessions/program/3/37.pdf . [Accessed Dec. 7, 2017].

[24] U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2015 Mathematics Assessment.

[25] C. Ashcraft and S. Blithe, "Women in IT: The facts, 2-16 update," 2016. [Online]. Available: https://www.ncwit.org/resources/women-it-facts-infographic-2016-update. [Accessed Jan.21, 2018].

[26] E. Sobiesk, J. Blair, G. Conti, M. Lanham, and H. Taylor, "Cyber education: A multi-level, multi-discipline approach," in *SIGITE 2015 Proceedings of the 16th Annual Conference on Information Technology Education*, 2015, pp. 43–47.

[27] M. Niess, R. Ronau, K. Shafer, S. Driskell, S. Harper, C. Browning, S. Özgün-Koca, and G. Kersaint, "Mathematics teacher TPACK standards and development model," 2oo9 [Contemporary Issues in Technology and Teacher Education, 9(1).

[28] Kansas State University Office of Educational Innovation and Evaluation, Mississippi Alliance for Women in Computing (MSAWC) Year 1 Annual Evaluation report. October 2017.