Mississippi BEST Robotics: An Analysis of Impact and Outcomes on Student Performance and Perceptions towards Earning STEM Degrees

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Abstract

Robotics is an innovative way of intertwining the fields of science, technology, engineering, and mathematics (STEM). Through robotics, students become competent and confident in abstract thinking, problem solving, teamwork, goal-setting, and leadership. Established in 1998, BEST Robotics Inc, a non-profit volunteer-based organization and network with approximately 45+ hubs across the United States provides students, regardless of socioeconomic status from public, private and home school groups and organizations the opportunity to explore the engineering design process via the design, development and testing of robots that can perform specific tasks on game fields. As a regional hub in BEST, Mississippi BEST (MS BEST) Robotics used surveys to evaluate the impact and outcomes of BEST Robotics on student performance and perceptions towards earning STEM degrees post involvement in a regional BEST Robotics Competition. MS BEST served approximately 500+ middle and high school students dispersed into 25 teams. As a result of participation in MS BEST, students enhanced their self-efficacies, became more familiar and comfortable with STEM concepts through the engineering design process, worked in teams to compete in exhilarating competitions which served as great performance assessments, gained transferrable skills in programming, marketing, technical writing, design-to-implementation and failure analysis, and developed increased interest to pursue degrees in STEM.

Introduction

Growth and enrichment within the STEM workforce will help to boost the economic growth and development in the U.S. However, inadequate STEM course preparation coupled with K-12 school demographics and trends in the labor market continue to remain an unwavering issue. Currently, there is a demand in the U.S. to produce qualified students, both at the K-12 and postsecondary levels with suitable STEM transferable skills and a knack for scientific exploration and innovation through engineering design to aid in the growth and enrichment of the U.S.'s economy. In 2004, the National Science Foundation noted that half of the economic growth within the U.S. over the past 50+ years is credited to the scientific innovation of the STEM workforce, which represents a minute 5% of the overall U.S. workforce.[1]

In order to strengthen the K-12 STEM pipeline and workforce, investments in outreach and student development are continually being developed, implemented and evaluated at the collegiate level to increase the diversity and enrollment of students in STEM disciplines. Investments in outreach and student development has led to common STEM activities and programs that promote active learning through hands-on activities, inquiry-based learning, curriculum supplements, engaged role models, and teacher involvement inside and outside of K-12 classrooms.[2-4] Such investments are helping the U.S. to produce students with an academic proficiency in STEM.

As the state of Mississippi remains a leader in agriculture, aquaculture and manufacturing, there is a need to increase the number of four-year degree holders throughout the state as seen in Figure 1. Approximately 19% of the state's total population attains a four-year

degree. Increasing the number of four-year degree holders within the state of Mississippi will help to boost the state's economic drive and innovation, in turn producing more startup businesses and productivity within the state. More interestingly, an increase in the number of STEM holders will help to enhance and grow the research and development intensity, high tech industries and patent activity throughout the state as compared to other states in the U.S. shown in Figure 2.

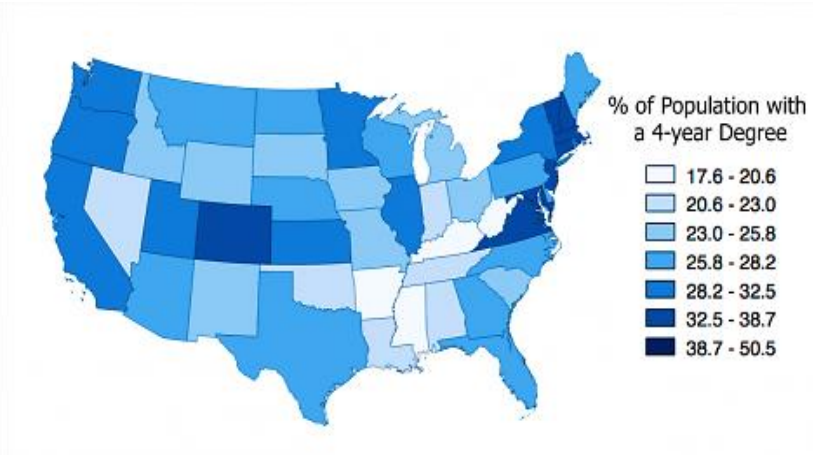

Figure 1. Most educated states in America adopted from Business Insider (2014).[5]

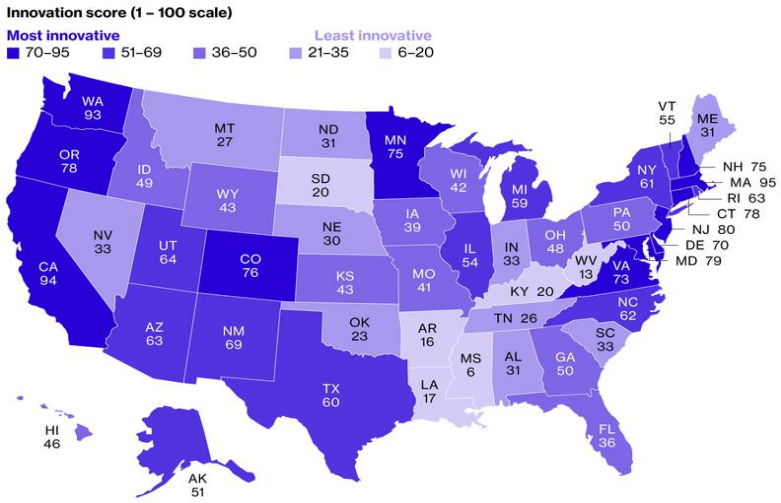

Figure 2. Most innovative states in the U.S. as of 2016. Figure adopted from the Bloomberg 2016 U.S. State Innovative Index (2016).[6]

To help stimulate interest in STEM throughout the state, Mississippi State University's Bagley College of Engineering has partnered with BEST Robotics Inc., a non-profit, volunteer-based organization to serve as a regional hub that provides an annual robotics competition to middle and high school students free of charge. Although there are several other robotics programs out there as listed in Table 1, MS BEST has a mission to inspire students to pursue careers in STEM through robotic design and competition. The goals of MS BEST are to instill in students the academic proficiency of science and engineering by enabling in them the ability to

foster critical thinking, problem solving, effective communication skills, and independent and team learning as they work through an engineering design plan to develop a competitive robot to fulfill an industrial need over a six-week timeframe. The program served approximately 25 teams which totaled to 500+ students representing public and private middle and high schools as well as homeschools.

community engagement

To attract students to MS BEST, the Hub Director recruits at middle and high schools across to the state of Mississippi. MS BEST is also advertised on the university's engineering outreach website. In addition, middle and high school administrators and teachers from previous MS BEST events, as well as potentially new schools (teams) are emailed details about the program and its competition.

Since MS BEST is a volunteer driven organization, the volunteers were comprised of K-12 teachers and staff, parents, industry representatives, retirees, undergraduate and graduate students, local community volunteer organizations as well university faculty and staff and student organizations. The volunteers provided support to teams and coaches in the form of mentoring, networking, fundraising and technical guidance. Coaches were either teachers, parents, industry representatives or university faculty/staff.

Public, private and home-school middle and secondary teachers as well as parents of the participants either served as coaches or mentors. Coaches provided guidance to the participants on robotic design through implementation of the robot every step of the way throughout the duration of the program. Parents ensured that the participants attended meetings and were involved in either the design, build or marketing aspect of the robot. Parents also helped to fundraise money to get the teams specially designed shirts and gadgets with the team's logo printed on them. Representatives from local manufacturing industries provided mentorship to MS BEST hub teams by assisting teams in cutting and building parts from their hand drawn and computer-aided drafting designs (CAD), providing technical insight on mechanical designs and builds, as well as building the competition fields for the teams to practice and compete on.

K-12 teachers, retirees, university faculty/staff, undergraduate and graduate students, along with student organizations such as the National Society of Black Engineers, Society of Women Engineers, Theta Tau, a professional engineering fraternity and the Mechanical Engineering Minority Organization, which is a local school organization helped to facilitate the program on practice day and competition day by helping to set up the game field, judge notebooks, robot design, and marketing of the robot. University students who were past participants of BEST served as head referees and game-field managers for the MS BEST competition, due to their familiarity with the BEST rules and compliance. Students who were pursuing degrees in Communication served as emcees on competition day.

Table 1: Comparison of robotics programs for various grade levels.

Program	Grade Level	Program Objectives	Associated Cost
4-H Robotics[7]	2nd – 8th	Outreach program established by the 4-H network and afterschool programs to develop and enhance the engineering skills of students through the design and function of robots.	Robotic kits cost $119 - $269
FIRST LEGO League	4th – 8th	Design, build and program autonomous robots to solve real-world tasks. Lego kits are provided and are easily assembled.	Approximately $900 for registration costs and kits for new teams. Veteran teams will pay less since the robot set can be used year after year.[8]
MSBEST	6th -12th	Students gain knowledge and employ innovation in a fun-filled, challenging and team-oriented environment that links the importance of robotic design and function to that of a real industrial need. Students develop and program robot from raw materials (wood, sheets of alumina, Styrofoam, etc.)	All associated costs are free to all middle and high schools.
FIRST Tech(nology) Challenge	7th -12th	Program was designed to challenge students to think innovatively and critically using the engineering design process. Lego kits are provided and are easily assembled.	Associated costs are approximately $2,700. The cost for international teams varies depending on the area. Since the parts are reusable, the fees for veteran times are typically lower. The fees include: registration, robot supplies, a small travel stipend and event registration.[9]
FIRST Robotics Competition	9th -12th	Design, build and program a remote controlled robot to solve a common real world problem. Develop and enhance the engineering skills and knowledge of students. Lego kits are provided and are easily assembled.	Annual associated costs are between $5000 and $6000; however, the cost varies depending on the area and the team level of participation.[10] Registration, robot kit, and game day fees are all included in the cost.

MS BEST is unique in that participants are supplied with kits containing materials such as PVC pipes, insulating wire, screws, plywood, batteries and their chargers, along with large and small motors and several other materials. Prior to putting those materials together to build a robot, participants must research the competition theme for that particular year. Knowing the particular theme allows students to brainstorm ideas on how to design the robot to perform tasks related to the theme. Participants brainstorm all of their ideas and designs in an engineering notebook. Once those designs are made, several members of the team build, wire and program

the robot, while others help to develop a plan to market the robot. If the robot does not perform as expected, participants continue to make modifications to the robot during the six-week timeframe allotted. A week prior to competition day, all teams are required to submit their notebook, team demographics, surveys, and consent forms. On competition day, all robots must meet compliance as specified by BEST Robotics Inc.

Within the 2016 competition of MS BEST's "Bet the Farm," participants were provided the opportunity to design, develop and test the performance of their robots to do specific tasks on a designed farm field. The use of robots to assist in farming activities such as planting corn seeds, harvesting ripe corn and hydroponic lettuce, crop irrigation and corralling farm animals such as pigs is currently a growing need for many farmers and BEST made it an imperative initiative to get students in the K-12 system involved. Having such agricultural technology reduces both manpower and labor time all while ensuring the safety of many farmers. As part of MS BEST's mission to increase STEM awareness and readiness across the state of Mississippi, the program evaluated the 2016 MS BEST team demographics along with their perceptions towards earning STEM degrees in the near future.

Methods

The findings of this paper were generated from demographic forms completed by each of the 21 teams and paper surveys completed by each individual, on each of the 21 teams. The primary objectives in evaluating the MS BEST robotics program were to assess

1. The demographics of the team/school participants from both the demographic form and survey.
2. The development and understanding of participants' past experiences as they related to engineering concepts from the survey.
3. The perceptions of the participants as they related to the MS BEST Robotics competition based on the survey.

The itemized survey included qualitative, quantitative and Likert-scale items to assess the impact of the MS BEST program. Approximately 21 of 25 teams that participated in the MS BEST Robotics competition responded to the surveys yielding an 84% response rate. Analysis of the data was performed using Statistical Package for the Social Sciences (SPSS) version 23.

MS BEST team demographics

To assess the MS BEST team demographics, seven variables were considered in the demographic data: a) participant's grade level, b) gender, c) ethnicity, d) years of MS BEST Robotics experience, e) position held on the robotics team, f) educational aspirations, and g) preferred mode of learning about robotics. According to the registration records, over 550 students participated in the 2016 MS BEST robotics competition. However, only 430 participants completed the survey, yielding an exceptional individual response rate of 78%.

While the competition is designed for intermediate and secondary students, data recorded on surveys indicated that several of the participants (n = 11; <3%) were elementary students. Intermediate students (Grades 6, 7, and 8) represented 32.7% of the participants (n = 133 students) and 64.3% (n = 263) of the participants were secondary students (Grades 9, 10, 11, and 12). Table 2 display the descriptive statistics for the grade level of the participants. Majority of the participants were Caucasian (69.4%). In comparing the ethnicity of the participants to that of

the K-12 population of Mississippi, it was found that African Americans (48.87%) compose most of the K-12 population followed by Caucasians (44.35%). All other ethnicities represented less than 5% of the K-12 population, as shown in Table 3[11]. It's worth noting that the Mississippi K-12 population consisted of all students from public schools and excluded students from private schools. Table 3 display the descriptive statistics for the ethnicity of the participants.

Table 2: Grade level of participants

Grade Level	n	Valid Percent
5	11	2.7
6	30	7.4
7	53	13
8	50	12.3
9	62	15.2
10	71	17.2
11	75	18.4
12	55	13.5
Total	407	100
System Missing	23	
Total	430	

Table 3: Ethnicity of participants

Ethnicity	Frequency	Valid Percent	Mississippi K-12 Population
African American	74	17.6	48.87
Caucasian	292	69.4	44.35
Asian/ Pacific Islander	23	5.5	1.11
Native American	3	0.7	0.24
Multiracial/Other	18	4.2	1.82
Hispanic	11	2.6	3.61
Total	421	100	100
System Missing	9		
Total	430		

The grade level, ethnicity and gender of each teams' composition were evaluated to examine if there were any differences. Nine of the teams were composed of 9^{th} – 12^{th} graders (42.8%), while six teams were composed of combinations of 6^{th} – 8^{th} graders and 9^{th}- 12^{th} graders (28.6%). Five teams were solely composed of 6^{th}- 8^{th} graders (23.8%). The remaining team was composed of a combination of K-5^{th} and 6^{th} – 8^{th} graders (4.8%). Figure 3 displays the composition of each team by grade level.

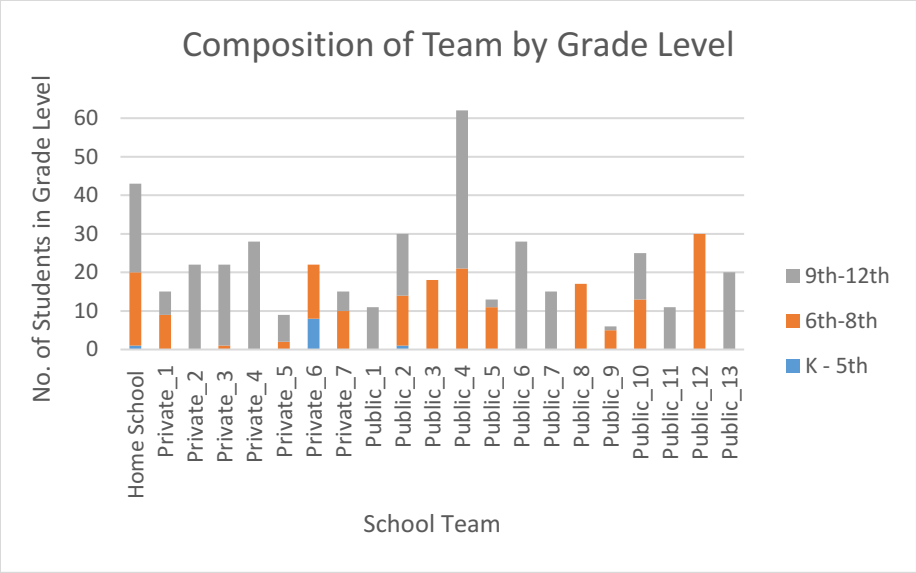

Figure 3. Composition of team by grade level.

In examining the composition of the teams by ethnicity, Caucasians represented the majority as seen in Figure 4. In examining Figure 5, males made up majority of each teams' composition. In terms of gender and ethnicity of the participants, the results of data analysis revealed that the composition of the 2016 participants was very similar to that of the STEM workforce. The majority of participants were Caucasian and male. Of the participants who completed a survey, 65.7% were male and 69.4% were Caucasian.

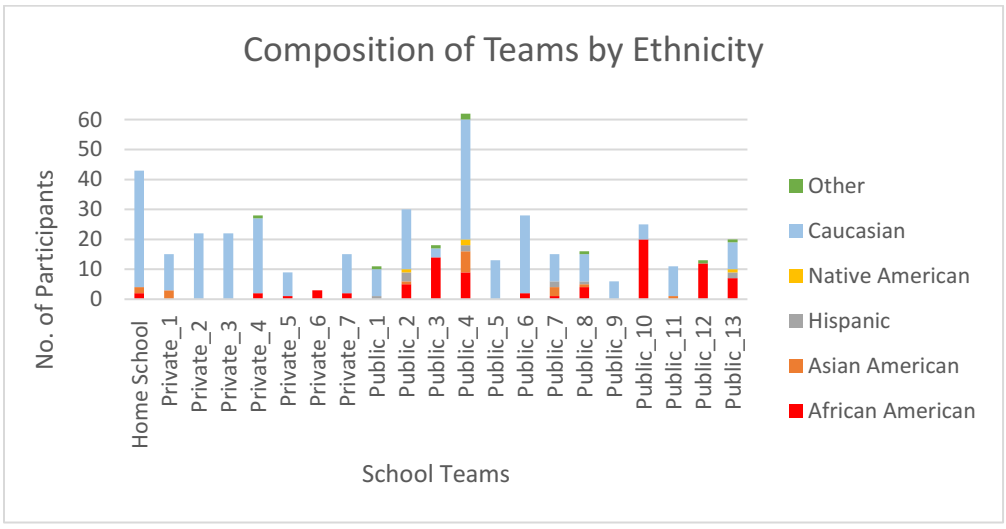

Figure 4. Composition of teams by ethnicity

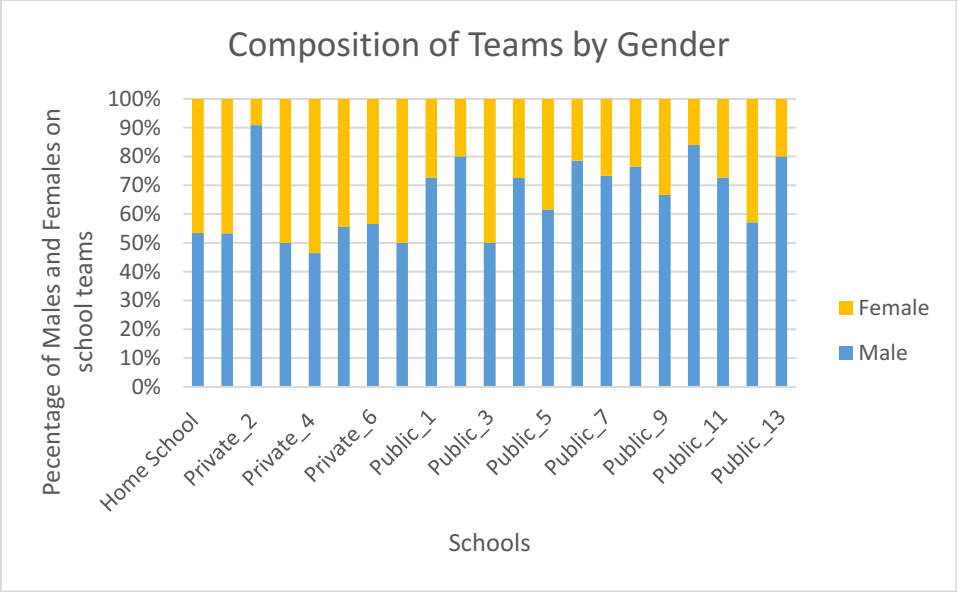

Figure 5. Composition of teams by gender.

Figure 6 and Figure 7 show the number of participants and mentors on each team. The average number of participants on each team was approximately 21 members. The minimum amount of members on a team was 6, while the maximum number of members was found to be 62 as shown in Figure 6. The average number of mentors on a team was approximately three, while the minimum was found to be one and the maximum, six. Figure 7 shows the results. Mentors were either coaches, parents, or industry partners.

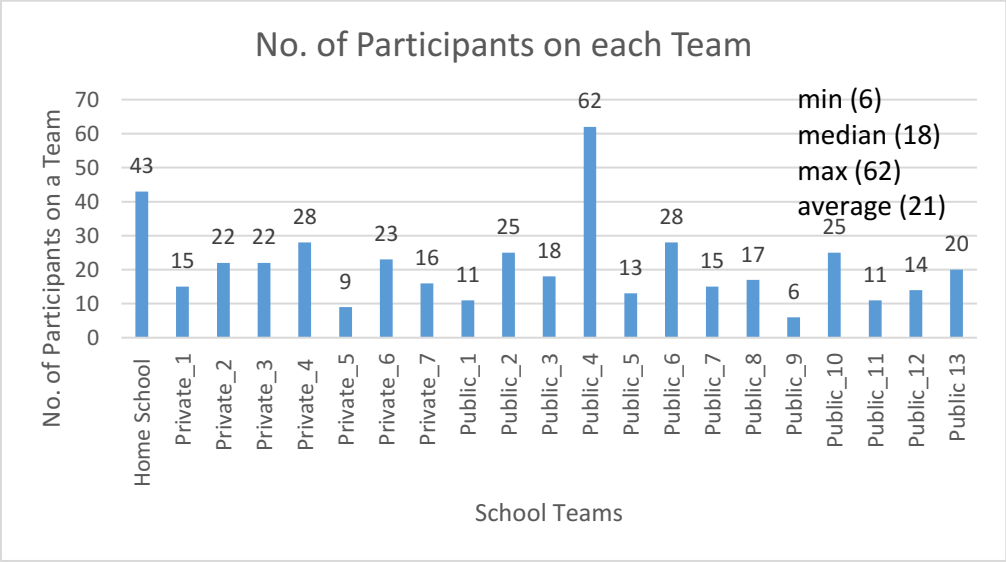

Figure 6. Composition of teams by number of participants on each team.

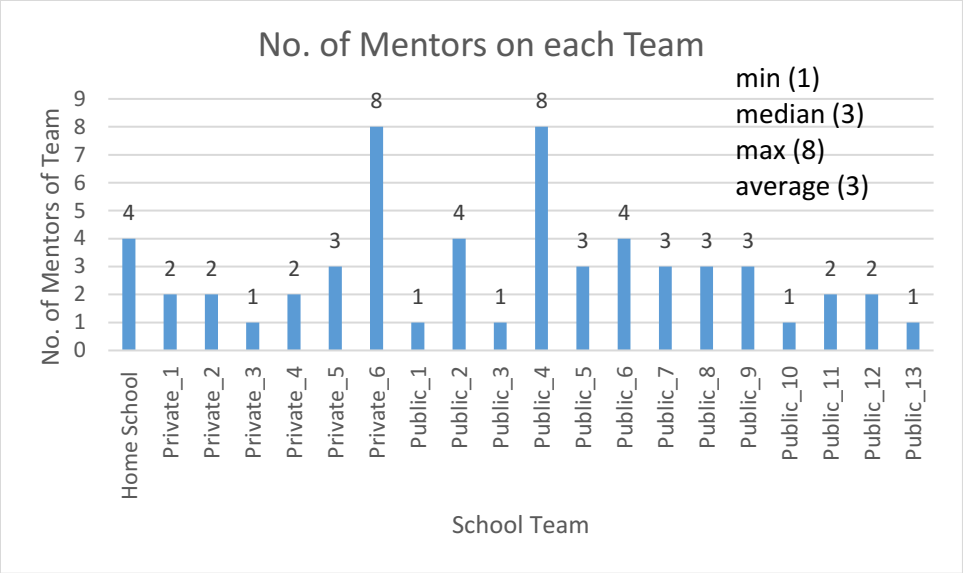

Figure 7. Composition of mentors on each team.

While not typically identified as demographic information, for the purposes of this evaluation, years of MS BEST Robotics experience and position held on the robotics team were defined as such. For the survey item on years of MS BEST Robotics experience, 409 participants recorded responses. The most frequently occurring response was that prior to 2016, the largest percentage (35.7%) of participants had one year of experience, followed closely by the percentage of participants (33.3%) indicating that 2016 was their first year of participating in the robotics competition. The remaining percentage (31.1%) of responses ranged from two years of experience to 12 years of experience recorded by one participant (see Table 4). However, the data recorded by this participant was invalid because the MS BEST Robotics Competition has only been in existence for 10 years.

Table 4: Years of MS BEST Robotics experience

Years of Experience	n	Valid Percent
0	136	33.3
1	146	35.7
2	71	17.4
3	27	6.6
4	10	2.4
5	10	2.4
6	6	1.5
7	1	0.2
10	1	0.2
12	1	0.2
Total	409	100
System Missing	21	
Total	430	

When examining the average years of experience by gender and ethnicity, the data revealed that there is not a statistically significant difference in years of experience by gender and ethnicity ($p>.05$) (see Table 5). The mean for females was 1.23 ($n=141$) and the mean for males was 1.32 ($n=263$). Although the data revealed that there is not a statistically significant difference in ethnicity (see Table 6), Native Americans ($n=3$) had a higher mean $M=2.33$, $SD=2.31$, while the Multiracial group ($n=12$) had the lowest mean $M=.75$, $SD=.965$. When examining the descriptive statistical data in more depth, one Native American had 5 years of experience in comparison to the Multiracial group which had on average 3 years of experience.

Table 5: Years of MS BEST Robotics experience by gender

Gender	n	Mean	Standard Deviation
Female	141	1.23	1.55
Male	263	1.32	1.49
Total	409		

Table 6: Years of MS BEST Robotics experience by ethnicity

Ethnicity	n	Mean	Standard Deviation
African American	71	0.94	1.16
White	284	1.42	1.6
Asian/Pacific Islander	23	0.87	0.92
Native American	3	2.33	2.31
Multiracial	12	0.75	0.965
Hispanic/Latino	11	1	1.34
Other	4	1.4	1.5
Total	408	1.28	1.5

In terms of position held within the various MS BEST teams, the majority (53.3%) of participants indicated that they held multiple positions, ranging in number from two positions to seven positions as listed in Table 7, which displays the descriptive statistics for the position held survey item. Moreover, many of the multiple positions held were not included as a choice on the survey, therefore, the participants wrote in many of the positions they held. Figure 3 displays the frequency of the different positions recorded by the 224 participants by gender who recorded multiple positions. Other than the responses in which participants recorded multiple positions, the second most frequently selected position was that of marketing and presentation. Seventy-one participants indicated that they were responsible for the marketing and presentation of their team's robot. A chi-square test was performed to determine the relationship between the gender of the participant and their position on the MS BEST team. Based on the results from the chi-square test ($\chi^2=18.60$, and $p<.05$), male participants were more likely to serve in technical roles than female participants (see Figure 8).

Table 7: Descriptive statistics for participants' positions on an MS BEST team

Team Position	Frequency	Valid Percent
Mechanical	5	1.2
Design Robot	24	5.7
Programming	24	5.7
Electrical/wiring	1	0.2
Build	18	4.3
Booth/sportsmanship	53	12.6
Marketing/presentation	71	16.9
Multiple Positions	224	53.3
Total	420	100
System Missing	10	
Total	430	

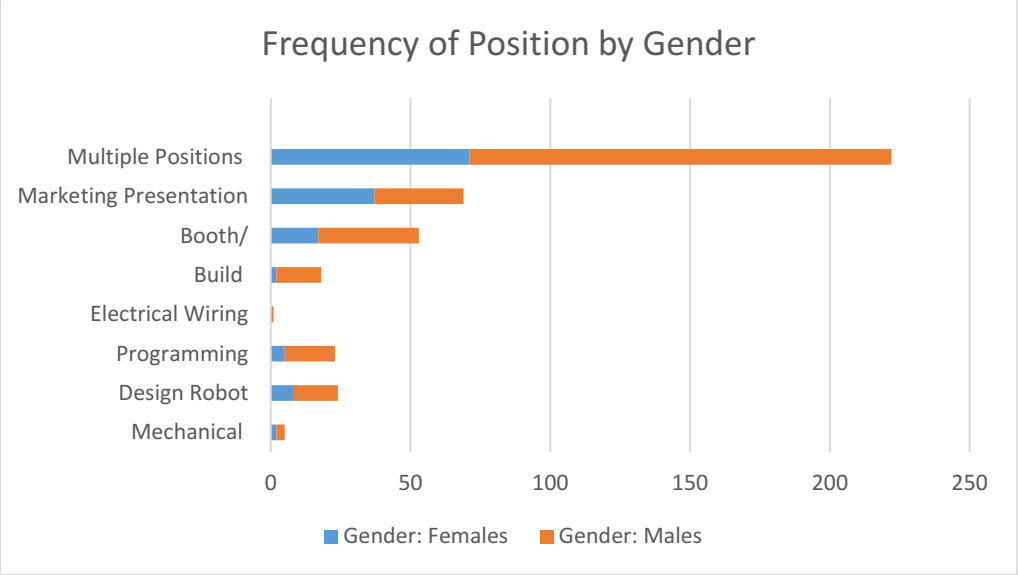

Figure 8. Frequency of positions on team by gender.

As a measure of educational aspirations, the participants were asked to identify the highest level of education they ever expected to achieve. For this item, 410 participants responded with the highest percentage (29.3%) indicating that they expected to earn either a Ph.D., MBA, or MD. The participants that indicated they expected to earn either a Bachelor's or Master's degree represented the second largest percentages tied at 25.4%. While representing a rather small percentage, 13.9%, it was surprising that 57 participants indicated that they did not expect to earn any degree or certificate. Table 9 displays the descriptive statistics for the educational aspirations survey item.

When examining educational aspirations of the participants by gender, the results of the data revealed that there is a statistical significant difference (p <.05); however, when examining educational aspirations of the participants by grade level, the data revealed that there is not a

statistically significant difference. Females aspired to attain higher degrees than males according to Table 10. Although, there is no statistical difference in the educational aspirations by grade level according to Table 11, it was found that 5th graders aspired to attain master's, PhD's and professional degrees, while 6th – 8th graders aspired to attain PhD's and professional degrees. On the high school level, 9th graders aspired to obtain mostly master's degrees, while 10th and 12th graders aspired to attain bachelor's degrees. Interestingly, 11th graders aspired to attain PhD's and professional degrees. The data is shown in Figure 9.

Table 9: Educational aspirations of the participants

Educational Levels	n	Valid Percent
No Degree or Certificate	57	13.9
Certificate	10	2.4
Associate's Degree	7	1.7
Bachelor's Degree	104	25.4
Post Baccalaureate Certificate	8	2
Master's Degree	104	25.4
Ph.D., MBA, or MD	120	29.3
Total	410	100
Missing System	20	
Total	430	

Table 10: Educational aspirations of the participants by gender

Gender	n	Mean	Standard Deviation
Female	134	5.28	1.96
Male	271	4.73	2.07
Total	405		

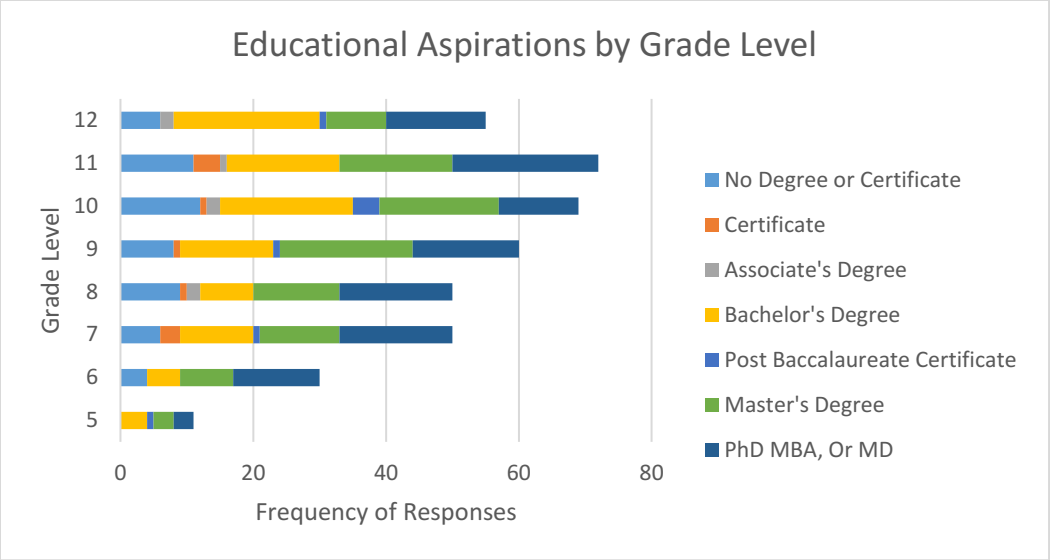

Figure 9. Educational Aspirations by Grade Level.

Table 11: Educational aspirations of the participants by middle or high school level

Grade Level	n	Mean	Standard Deviation
Middle School	130	5.08	2.14
High School	255	4.78	2.03
Total	385		

The final demographic survey item, preferred mode of robotics learning outside of the classroom, listed the following five learning modes: a) instructional videos, b) informative articles, c) power point presentations, d) podcast, and e) interactive multimedia. The participants were also given the option to write-in their own preferred mode. The results of data analysis revealed that the highest percentage of participants (41.5%) did not have a single best way or preferred mode of learning about robotics. However, for the modes listed, it appears that the single most popular mode of learning about robotics for the participants of the 2016 competition was that of viewing instructional videos. The least popular mode of learning for this group of participants was watching a podcast. The results are listed in Table 12.

Table 12: Preferred modes of learning about robotics outside of the classroom

Mode of Learning	Frequency	Valid Percent
Instructional Videos	138	33.9
Informative Articles	20	4.9
Power Point Presentations	33	8.1
Podcasts	13	3.2
Interactive Multimedia	22	5.4

Other Modes	12	3
Multiple Modes	169	41.5
Total	407	100

In examining if there was a difference between gender and the preferred modes of learning, analysis of the data revealed that both females and males preferred to learn multiple ways. The least preferred mode of learning was through other modes which consisted of learning from mentors, other teams, parents, workshops, hands-on-demonstrations, intro to engineering classes, etc. The analysis was similar for grade level. Also, the results of analysis revealed that there is no statistically significant difference between preferred mode of learning about robotics by gender ($p>.05$) or grade level ($p>.05$). Table 13 and Table 14 list the results of the preferred modes of learning by gender and grade level respectively.

Table 13: Preferred modes of learning about robotics by gender

Modes of Learning	Female	Male
Instructional Videos	30.4	36.2
Informative Articles	3.7	5.7
PowerPoint	11.1	6.4
Podcasts	1.5	4.2
Interactive Multimedia	8.1	4.2
Other	3.0	2.3
Multiple	42.2	41.1
Valid Percent	100	100

Table 14: Preferred modes of learning about robotics by grade level

Mode of Learning	Middle School	High School
Instructional Videos	30.5	35.6
Informative Articles	2.3	6.7
PowerPoint	8.6	8.3
Podcasts	3.1	3.6
Interactive Multimedia	3.9	5.5
Other	3.1	2.4
Multiple	48.4	37.9
Valid Percent	100	100

concepts of engineering

This section describes the participants' perceived knowledge of engineering concepts and how they acquired that knowledge. The first set of questions asked the participants to rate their level of knowledge in four areas (mechanical design, robot programming, electrical wiring, and mechanical build) and the second, and final, set of questions for Concepts of Engineering asked the participants to indicate how they learned about those same four areas. As indicators of levels of knowledge, the participants had five choices on a Likert-scale ranging from No Knowledge (1point) to Exceptional Knowledge (5 points). For each engineering concept (mechanical design, robot programming, electrical wiring, and mechanical build), participants were awarded varying points depending on their response. In which case, the Likert-scale items were converted to interval data to accommodate not only mode and median analysis, but also to determine an overall mean for the group of participants. Surprisingly, prior to any rounding, the average score in each of the areas was below the score of 3 (see Table 15). A score of 3 corresponded to the participants having Some Knowledge, which was nested between Very Little Knowledge and A Lot of Knowledge. Very few of the participants indicated that they had exceptional knowledge with any of the concepts. In fact, the mode for each of the four areas was either No Knowledge (Robot Programming Knowledge), Very Little Knowledge (Electrical Wiring Knowledge) or Some Knowledge (Mechanical Design Knowledge and Mechanical Build Knowledge). Table 19 display the results of the analysis of concepts of engineering knowledge.

Table 15: Descriptive statistics for Concepts of Engineering Knowledge

	Mechanical Knowledge	Robot Programming Knowledge	Electrical Wiring Knowledge	Mechanical Build
N	413	410	411	412
System Missing	17	20	19	18
Mean	2.68	2.08	2.36	2.82
Mode	3	1	2	3

In examining the difference between gender and participants' perceived knowledge of concepts of engineering, it was found that males on average have a slightly higher knowledge of electrical wiring, mechanical build and mechanics (mechanical knowledge) as shown in Table 16. However, females and males both have similar perceived knowledge of robot programming. When examining the participants' perceived knowledge of concepts of engineering by grade level, a statistically significant difference between grade level and mechanical knowledge ($p<.05$) existed. High school students (9^{th} – 12^{th}) reported having more mechanical knowledge than the middle school participants (6^{th} – 8^{th}). When examining the grade level of the participants' and their perceived knowledge of concepts of engineering, data analysis revealed that there was a statistically significant difference between grade level and mechanical knowledge ($p<.05$). High school students on average, had more mechanical knowledge than the middle school participants. The data also revealed there was not a statistical significant difference between the participants' perceived knowledge by grade level for mechanical build, robot programming knowledge and electrical wiring knowledge. Table 17 list the results.

Table 16: Descriptive statistics for Concepts of Engineering Knowledge by gender

Knowledge Type	Gender	n	Mean	Std. Deviation
Electrical Wiring Knowledge	Female	137	2.007	1.1081
	Male	269	2.543	1.1951
	Total	406	2.362	1.1923
Mechanical Build	Female	139	2.424	1.1855
	Male	268	3.015	1.1448
	Total	407	2.813	1.1909
Mechanical Knowledge	Female	139	2.403	1.0613
	Male	269	2.81	1.0136
	Total	408	2.672	1.0468
Robot Programming Knowledge	Female	136	1.971	1.0607
	Male	269	2.134	1.0879
	Total	405	2.079	1.0803

Table 17: Descriptive statistics for Concepts of Engineering Knowledge by grade level

Knowledge Type	Grade Level	n	Mean	Std. Deviation
Electrical Wiring Knowledge	middle school	130	2.331	1.1838
	high school	256	2.398	1.1805
	Total	386	2.376	1.1805
Robot Programming Knowledge	middle school	130	2.046	1.0701
	high school	255	2.102	1.0856
	Total	385	2.083	1.0793
Mechanical Knowledge	middle school	132	2.523	0.9687
	high school	256	2.77	1.0542
	Total	388	2.686	1.0313
Mechanical Build	middle school	131	2.733	1.233
	high school	255	2.89	1.1687
	Total	386	2.837	1.1917

To see if a relationship existed for the participants' position on team and concepts of engineering knowledge, a Bivariate Correlation test was performed. Results of the correlation test revealed that there was no significant relationship between position on team and mechanical knowledge, robot programming knowledge, and electrical wiring knowledge; however, there is a statistically significant relationship between position on team and mechanical build (see Table 18). Although mechanical build is significant the relationship was weak (r=.107).

Table 18: Participants' perceived knowledge of concepts of engineering

		Position on team	Mechanical Knowledge	Robot Programming Knowledge	Electrical Wiring Knowledge	Mechanical Build
Position on team	Pearson Correlation	1	0.06	-0.064	0.087	.107*
	Sig. (2-tailed)		0.228	0.199	0.079	0.031
	n	420	411	408	409	410

Table 19: Descriptive statistics for Concepts of Engineering Knowledge

		n	Valid Percent
Mechanical Design	No Knowledge	62	15
	Very Little Knowledge	106	25.7
	Some Knowledge	167	40.4
	A Lot of Knowledge	60	14.5
	Exceptional Knowledge	18	4.4
	Total %		100
Robot Programming	No Knowledge	155	37.8
	Very Little Knowledge	124	30.2
	Some Knowledge	86	21
	A Lot of Knowledge	32	7.8
	Exceptional Knowledge	13	3.2
	Total %		100
Electrical Wiring	No Knowledge	116	28.2
	Very Little Knowledge	128	31.1
	Some Knowledge	95	23.1
	A Lot of Knowledge	46	11.3
	Exceptional Knowledge	26	6.3
	Total %		100
Mechanical Build	No Knowledge	70	17
	Very Little Knowledge	82	19.9
	Some Knowledge	152	36.9
	A Lot of Knowledge	73	17.7
	Exceptional Knowledge	35	8.5
	Total %		100

As a follow-up to questions of the participants' perceived knowledge in mechanical design, robot programming, electrical wiring, and mechanical design, they were asked to indicate how they learned about the four concepts (mechanical design, robot programming, electrical wiring, and mechanical build). For this series of items, the participants had the following six

choices: a) Mentors, b) Internet, c) Other members of my team, d) Other teams, e) School, or f) Have not learned about the topic yet.

The results of the analysis of data revealed that the least common method of the participants learning about the various topics was from members of other teams. Due to the highly competitive nature of the MS BEST Robotics Competition, this finding was not surprising. The results revealed that for each topic (mechanical design, robot programming, electrical wiring, and mechanical build) only 6 to 8 participants indicated that they learned about the topic from a team other than their own. For the concepts of mechanical design and mechanical build, the highest percentages (34.7% and 30.3%, respectively) of students indicated that they learned about those concepts from members of their own team. For the remaining two concepts, robot programming and electrical wiring, the highest percentages (34.8% and 30%, respectively) of participants indicated that they had not learned about the concepts yet. The most surprising finding from this series of analyses was the fact that on average, only 9% of the participants indicated that they learned about any of the concepts in school. Tables 20 display the descriptive statistics from this series of analyses.

Table 20: Participants' Methods of Learning about each skill

	Methods of Learning	n	Valid Percent
Mechanical Design	Mentor	84	20.9
	Internet	28	7
	Members of Team	139	34.7
	Other teams	6	1.5
	School	40	10
	Have not Learned Yet	59	14.7
	Multiple Methods	45	11.2
	Total	401	100
Robot Programming	Mentor	54	13.5
	Internet	41	10.3
	Members of Team	89	22.3
	Other teams	8	2
	School	41	10.3
	Have not Learned Yet	139	34.8
	Multiple Methods	27	6.8
	Total	399	100
Electrical Wiring	Mentor	83	20.9
	Internet	37	9.3
	Members of Team	97	24.4
	Other teams	7	1.8
	School	28	7.1
	Have not Learned Yet	119	30
	Multiple Methods	26	6.5
	Total	397	100

Mechanical Build	Mentor	106	26.3
	Internet	32	7.9
	Members of Team	122	30.3
	Other teams	7	1.7
	School	32	7.9
	Have not Learned Yet	66	16.4
	Multiple Methods	38	9.4
	Total	403	100

The next section examined each participants' methods of learning about each skill by grade level. When examining the data, middle and high school students preferred to learn mechanical design from other members of the team. Both, middle and high school students had not learned robot programming and electrical wiring yet. Surprisingly, for the mechanical build, middle school participants preferred learning from a mentor (33.3%) while high school participants preferred learning this skill from other members of the team (32.1%). The results are listed in Table 21.

Table 21**:** Participants' Methods of Learning about each skill by grade level

	Methods of Learning	middle school	high school
Mechanical Design	Mentors	25.4	19.4
	Internet	9.5	6.3
	Other members of my team	33.3	35.7
	Other teams	1.6	1.6
	School	7.1	9.9
	Have Not Learned Yet	16.7	12.7
	Multiple Answers	6.3	14.3
	Total	100.0	100.0
Robotic Programming	Mentors	12.8	14.0
	Internet	15.2	8.0
	Other members of my team	23.2	22.4
	Other teams	2.4	2.0
	School	8.0	10.8
	Have Not Learned Yet	34.4	34.4
	Multiple Answers	4.0	8.4
	Total	100.0	100.0
Electrical Wiring	Mentors	26.8	19.1
	Internet	11.4	8.8
	Other members of my team	19.5	26.7
	Other teams	4.1	0.8
	School	4.9	7.6
	Have Not Learned Yet	32.5	27.5

	Multiple Answers	0.8	9.6
	Total	100.0	100.0
Mechanical Build	Mentors	33.3	23.0
	Internet	9.5	7.5
	Other members of my team	26.2	32.1
	Other teams	2.4	1.6
	School	7.1	7.5
	Have Not Learned Yet	18.3	15.5
	Multiple Answers	3.2	12.7
		100.0	100.0

participants' perceptions of their abilities and their team experience

The third section of the assessment included 18 Likert-scale items, covering three general areas with responses ranging from Strongly Agree (5 points) to Strongly Disagree (1 point), as a means of identifying the participants' perceptions of their own abilities and their perceptions of their MS BEST Robotics team experience. Eight items were designed to gather the participants' perceptions of their own abilities. Six items were designed to gather participants' perceptions of their team experience. Four items were designed to gather participants' perceptions of the role played by the coaches/mentors (adults) on the team. The following section presents the results of the analysis of data used to gather the participants' perceptions.

The mean scores for the eight items used to determine the participants' perceptions of their various abilities ranged from 2.69 (I am certain that I can fix the software program for a robot.) to 4.42 (I am comfortable working on a project with others.). A score of 2.69 indicates that on average, the participants tended to disagree with the statement that they were certain that they could fix the software program for a robot while the score of 4.42 indicated that they were comfortable working with other on a project. For the most part, the largest number of participants either agreed or strongly agreed with all of the statements except for one of the statements (I am certain that I can fix the software program for a robot.). For this statement, the mode was 3, indicating that most participants were neutral, meaning they neither agreed nor disagreed with the statement. Table 22 displays the descriptive statistics for these eight items.

Table 22: Participants' Perception of Ability

Participants' Abilities	n	Mean	Mode
I am comfortable working on a project with others.	419	4.42	5
I am confident about my ability to use science to develop and design projects.	415	3.94	4
I am certain that I can build a LEGO or similar robot by following design instructions.	418	4.2	5
I am certain that I can fix the software program for a robot.	416	2.69	3
I am confident that I can prepare and deliver a presentation.	411	3.73	5
I know how to find the information that I need to solve difficult problems.	410	3.92	4

I can set and meet goals for long-term projects.	413	4.07	4
I am confident sharing my ideas with others.	416	4.19	5

The participants' perception of ability by gender were analyzed. More females stated that they were confident about their ability to use science to develop and design projects, were more certain that they could build a LEGO or similar robot by following design instructions, and were certain they could fix the software program for a robot. Surprisingly, analysis of the data revealed that more males stated that they could set and meet goals for long term projects. Table 23 list the results of the data analysis.

Table 23: Participants' Perception of Ability by gender

Participants Abilities	Gender	n	Mean	Std. Deviation
I am comfortable working on a project	Female	141	1.574	0.699
	Male	273	1.59	0.800
	Total	414	1.585	0.766
I am confident about my ability to use science to develop and design projects.	Female	138	2.196	1.066
	Male	272	2	0.893
	Total	410	2.066	0.958
I am certain that I can build a LEGO or similar robot by following design instructions	Female	141	2.057	1.176
	Male	272	1.673	0.941
	Total	413	1.804	1.042
I am certain that I can fix the software program for a robot that.	Female	140	3.55	1.115
	Male	271	3.17	1.139
	Total	411	3.299	1.144
I am confident that I can prepare and deliver a presentation	Female	139	2.187	1.183
	Male	268	2.328	1.157
	Total	407	2.28	1.166
I know how to find the information that I need to solve difficult problems.	Female	138	2.09	0.911
	Male	267	2.07	0.851
	Total	405	2.08	0.871
I can set and meet goals for long-term projects.	Female	139	1.813	0.786
	Male	269	1.989	0.891
	Total	408	1.929	0.860
I am confident sharing my ideas with others.	Female	140	1.807	0.936
	Male	272	1.813	0.892
	Total	412	1.811	0.906

The participants' perception of ability by grade level were analyzed. The participants' perceptions of the ability by grade level differed for the "I am confident that I can prepare and deliver a presentation" and "I know how to find info that I need to solve difficult problems." Middle school participants had more confidence in their ability to prepare and deliver a presentation, and had more confidence in their ability to find and gather information to solve

difficult problems based on their means *M*=2.373 and *M*=1.762, respectively. The other items listed had similar means for both middle and high school students. The results are listed in Table 24.

Table 24: Participants' Perception of Ability by grade level

Participants Abilities	Grade Level	n	Mean	Std. Deviation
I am comfortable working on a project	middle school	132	1.606	0.779
	high school	261	1.567	0.744
	Total	393	1.58	0.756
I am confident about my ability to use science to develop and design projects.	middle school	131	2.053	0.923
	high school	260	2.054	0.985
	Total	391	2.054	0.963
I am certain that I can build a LEGO or similar robot by following design instructions	middle school	132	1.833	1.099
	high school	260	1.788	1.020
	Total	392	1.804	1.046
I am certain that I can fix the software program for a robot that.	middle school	130	3.238	1.098
	high school	260	3.308	1.141
	Total	390	3.285	1.126
I am confident that I can prepare and deliver a presentation	middle school	129	2.372	1.238
	high school	257	2.214	1.134
	Total	386	2.267	1.171
I know how to find the information that I need to solve difficult problems.	middle school	126	1.762	0.916
	high school	257	1.56	0.711
	Total	383	1.627	0.789
I can set and meet goals for long-term projects.	middle school	131	1.969	0.877
	high school	258	1.895	0.865
	Total	389	1.92	0.868
I am confident sharing my ideas with others.	middle school	131	1.794	0.892
	high school	260	1.785	0.883
	Total	391	1.788	0.885

Examination of the participants' responses for the six items gathering their perceptions of their team experience revealed that on average, the participants were either neutral to the statements or they agreed with the statements. For the item stating that they had demonstrated the technology used for MS BEST Robotics to family and friends, it was noted that nearly one-third (29.1%) of the participants either disagreed or strongly disagreed. However, over 80% of the participants perceived that their team had a good chance to win something at the competition. Moreover, one of the most meaningful and significant findings from this section of the survey was the finding that 82% of the participants perceived that they had learned a new skill through their MS BEST Robotics experience. The results of the analyses for this section of the survey are displayed in Table 25.

Table 25: Participants' Perception of Team Experience

Statements of Experience	n	Mean	Mode
I demonstrated to a friend or family member how to use the technology from BEST Robotics.	416	3.23	3
I had a chance to do lots of different jobs on my team.	413	4.09	5
I had a chance to play a leadership role on my team.	415	3.69	5
I learned new skills while working on the team.	414	4.34	5
I felt like I really belonged on my team.	414	4.31	5
I almost always felt that my team had a good chance to win something at the competition.	412	4.39	5

The participants' perception of team experience by gender was gathered and analyzed. Based on the results of the analysis, there were no differences between the perceptions of males and females and their experiences on a team. The standard deviations were pretty close in each category. The results are listed in Table 26. To examine if there was a relationship between the participants' leadership on a team and the years of involvement in MS BEST, a Bivariate test was performed. Results of the test revealed that there was a weak (small negative) correlation between the participants' leadership role on the team and years of experience. The results are shown in Table 27.

Table 26: Participants' Perception of Team Experience by gender

Statements of Experience	Gender	n	Mean	Std. Deviation
I showed a friend or family member how to use the technology from BEST Robotics.	Female	139	2.806	1.279
	Male	272	2.768	1.2921
	Total	411	2.781	1.2862
I had a chance to do lots of different jobs on my team.	Female	139	1.878	1.0664
	Male	270	1.922	1.03
	Total	409	1.907	1.0414
I had a chance to play a leadership role on my team.	Female	140	2.164	1.221
	Male	270	2.378	1.2897
	Total	410	2.305	1.2692
I learned new skills while working on the team.	Female	140	1.65	0.7579
	Male	269	1.677	0.8439
	Total	409	1.667	0.8147
I felt like I really belonged on my team.	Female	139	1.647	0.8329
	Male	270	1.722	0.8797
	Total	409	1.697	0.8638
I almost always felt that my team had a good chance to win something at the competition	Female	137	1.577	0.7926
	Male	270	1.633	0.842
	Total	407	1.614	0.8252

Table 27: Participants' Perceptions and Leadership Role Relations to Years of Experience

		Position on team	Mechanical Knowledge
I had a chance to play a leadership role on my team.	Pearson Correlation	1	-.236**
	Sig. (2-tailed)		.000
	n	415	404
Year(s) of Involvement	Pearson Correlation	-.236**	1
	Sig. (2-tailed)	.000	
	n	404	409

The last series of questions on the Participants' Perceptions of their Abilities and their Team Experience portion of the survey examined participants' perceptions of the roles adults played on the team. The analysis of data collected for the four items examining the adults' roles revealed that for the most part participants perceived that the adults played a minor role on the teams. As an example of this perception, the mode for the item "The adults on my team did most of the difficult jobs in building the robot" was 1, indicating that the participants strongly disagreed with this statement. In fact, nearly 60% of the participants either disagreed or strongly disagreed with this statement. The results gathered for the remaining three statements on this portion of the survey also indicated that the perceptions of most participants were that the adults played a minor role on the team. Table 28 display the results of the analysis of data from the survey.

Table 28: Participants' Perceptions of Adults Role on Team

Statements of Experience	n	Mean	Mode
The adults on my team did most of the difficult jobs in building the robot.	413	2.21	1
Students on my team made the important decisions, not the adults.	417	4.3	5
I had a chance to get to know at least one of the adults on my team very well.	407	4.12	5
I felt like I learned a lot from the adults on my team.	408	4.13	5

participants' perceptions of the MS BEST Robotics Competition

The final two sections of the paper serve as a direct evaluation of the MS BEST Robotics Competition from the perspective of the participants. The first portion of this section contained items to measure participants' perception of the impact of the competition and the second portion contained items to measure their overall perceptions of the competition.

Participants' Perceptions of MS BEST Robotics Competition Impact

The first portion, Participants' Perceptions of MS BEST Robotics Competition Impact, included 15 Likert-scale items (Strongly Disagree to Strongly Agree) designed to uncover

participants' perceptions of the impact of their experience in the MS BEST Robotics Competition on various school engagement factors. Of the 15 items included on this portion of the survey, the results of data analysis revealed that 12 had a mode of 5 (indicating strong agreement). The three statements (I became more interested in a career that involved math, science or technology as a result of BEST; My grades have improved since being in the BEST Robotics program; and My attendance has improved since being in the BEST Robotics program) without a mode of 5 had a mode of 3, indicating that the highest number of participants neither agreed nor disagreed with the statements.

Overall, the responses were very favorable. In fact, 14 of the 15 items had over 50% of the respondents either agreeing or strongly agreeing to the positive statements of MS BEST Robotics Competition's impact. The one item that failed to receive at least 50% agreement was the item that stated "My grades have improved since being in the MS BEST Robotics program". For this item, only 49.8% of the respondents agreed or strongly agreed. However, while very few participants (40 participants – 9.8%) disagreed or strongly disagreed with the statement, a large percentage of participants (40.3% - 165 participants) were neutral, neither agreeing nor disagreeing. For the remaining 14 items, the percentages of participants either agreeing or strongly agreeing to statements of positive impact ranged from 54.6% (My attendance has improved since being in the BEST Robotics program) to 82.3% (I am satisfied with my experience in the MS BEST Robotics program). Table 29 display the results for this series of data analyses.

Table 29: MS BEST Robotics Competition Perceptions of Impact Descriptive Statistics

Perceptions of Impact	n	Mean	Mode
I gained a sense of self-confidence by being in BEST.	410	3.97	5
My interest in science and technology greatly increased as a result of being in BEST.	410	4	4 & 5
I gained a better idea of what I wanted to study in college or vocational school as a result of BEST.	410	3.8	5
I became more interested in a career that involved math, science or technology as a result of BEST.	410	3.69	3
BEST helped motivate me to do better in school.	409	3.81	5
I gained a better understanding of how math, science and technology are used to solve problems in the real world.	409	4.07	5
BEST made me want to help younger students learn more about math and science.	408	3.72	5
BEST helped me understand the value of working on a team.	409	4.2	5
I feel actively engaged in learning.	409	4.18	5
I have access to the resources and materials I need in order to be successful with my learning.	410	4.23	5
My experience in the Robotics program has contributed to my growth in developing future college and/or career goals.	409	4.01	5
I am satisfied with my experience in the Robotics program.	407	4.3	5

My grades have improved since being in the BEST Robotics program.	409	3.64	3
My attendance has improved since being in the BEST Robotics program.	405	3.72	3
Because I have participated in BEST Robotics program, I want to take Science, Technology, Engineering, and Math courses in intermediate, high school, and/or college.	408	3.91	5

The participants' perceptions of impact by gender and impact by grade level were gathered and analyzed. Based on the means and standard deviations listed in Table 30, more males, on average, wanted to help younger students learn more about math and science. When examining the participants' perceptions of impact by grade level, two differences were found. The data revealed that more middle school students' perception from their experience in the robotics program has contributed to their growth in developing future college and career goals. Middle school participants' also indicated that their grades have improved since being in the BEST robotics program (see Table 31).

Table 30: MS BEST Robotics Competition Perceptions of Impact by gender

Perceptions of Impact	Gender	n	Mean	Std. Deviation
I gained a sense of self-confidence by being in BEST.	Female	137	1.978	0.935
	Male	268	2.071	1.005
	Total	405	2.04	0.982
My interest in science and technology greatly increased as a result of being in greatly increased as a result of being in BEST	Female	137	1.978	0.927
	Male	268	2.011	0.981
	Total	405	2	0.962
I gained a better idea of what I wanted to study in college or vocational school as a result of BEST.	Female	137	2.292	1.044
	Male	268	2.287	1.623
	Total	405	2.289	1.452
I became more interested in a career that involved math, science or technology as a result of BEST.	Female	137	2.409	1.075
	Male	268	2.272	1.127
	Total	405	2.319	1.110
BEST helped motivate me to do better in school.	Female	136	2.051	1.084
	Male	268	2.257	1.026
	Total	404	2.188	1.049
I gained a better understanding of how math, science and technology are used to solve problems in the real world.	Female	136	1.86	0.888
	Male	268	1.978	0.971
	Total	404	1.938	0.944
BEST made me want to help younger students learn more about math and science.	Female	137	2.073	1.075
	Male	266	2.395	1.129
	Total	403	2.285	1.120
BEST helped me understand the value of working on a team.	Female	137	1.723	0.855

	Male	267	1.843	0.857
	Total	404	1.802	0.857
I feel actively engaged in learning.	Female	137	1.715	0.804
	Male	267	1.884	0.980
	Total	404	1.827	0.926
I have access to the resources and materials I need in order to be successful with my learning.	Female	137	1.693	0.772
	Male	268	1.81	0.838
	Total	405	1.77	0.817
My experience in the Robotics program has contributed to my growth in developing future college and/or career goals.	Female	137	1.949	0.934
	Male	267	2.011	0.987
	Total	404	1.99	0.968
I am satisfied with my experience in the Robotics program.	Female	136	1.676	0.825
	Male	266	1.722	0.868
	Total	402	1.706	0.852
My grades have improved since being in the BEST Robotics program.	Female	137	2.234	1.073
	Male	267	2.427	1.057
	Total	404	2.361	1.065
Because I have participated in BEST Robotics program, I want to take Science, Technology, Engineering, and Math courses in intermediate, high school, and/or college.	Female	136	2.176	1.088
	Male	267	2.064	1.144
	Total	403	2.102	1.125
My attendance has improved since being in the BEST Robotics program.	Female	133	2.23	1.112
	Male	267	2.31	1.106
	Total	400	2.29	1.108

Table 31: MS BEST Robotics Competition Perceptions of Impact Descriptive Statistics by grade level

Perceptions of Impact	Grade Level	n	Mean	Std. Deviation
I gained a sense of self-confidence by being in BEST.	middle school	130	2.085	1.020
	high school	255	1.953	0.921
	Total	385	1.997	0.956
My interest in science and technology greatly increased as a result of being in BEST.	middle school	130	2.046	1.070
	high school	255	1.965	0.915
	Total	385	1.992	0.970
I gained a better idea of what I wanted to study in college or vocational school as a result of BEST.	middle school	130	2.415	1.167
	high school	255	2.216	1.596
	Total	385	2.283	1.467
I became more interested in a career that involved math, science or technology as a result of BEST.	middle school	130	2.377	1.209
	high school	255	2.251	1.057
	Total	385	2.294	1.111

BEST helped motivate me to do better in school.	middle school	129	2.217	1.082
	high school	255	2.141	1.017
	Total	384	2.167	1.039
I gained a better understanding of how math, science and technology are used to solve problems in the real world.	middle school	129	2.031	1.045
	high school	255	1.855	0.873
	Total	384	1.914	0.937
BEST made me want to help younger students learn more about math and science.	middle school	129	2.341	1.122
	high school	254	2.224	1.100
	Total	383	2.264	1.107
BEST helped me understand the value of working on a team.	middle school	130	1.792	0.869
	high school	254	1.748	0.819
	Total	384	1.763	0.836
I feel actively engaged in learning.	middle school	130	1.9	0.955
	high school	254	1.748	0.871
	Total	384	1.799	0.902
I have access to the resources and materials I need in order to be successful with my learning.	middle school	130	1.838	0.879
	high school	255	1.702	0.767
	Total	385	1.748	0.808
My experience in the Robotics program has contributed to my growth in developing future college and/or career goals.	middle school	129	2.116	1.065
	high school	255	1.898	0.899
	Total	384	1.971	0.962
I am satisfied with my experience in the Robotics program.	middle school	129	1.682	0.848
	high school	253	1.68	0.838
	Total	382	1.681	0.840
My grades have improved since being in the BEST Robotics program.	middle school	129	2.488	1.126
	high school	255	2.259	1.025
	Total	384	2.336	1.064
Because I have participated in BEST Robotics program, I want to take Science, Technology, Engineering, and Math courses in intermediate, high school, and/or college.	middle school	129	2.163	1.204
	high school	254	2.051	1.075
	Total	383	2.089	1.120
My attendance has improved since being in the BEST Robotics program.	middle school	127	2.35	1.225
	high school	253	2.22	1.050
	Total	380	2.27	1.111

participants' perceptions of their MS BEST robotics competition experience

The final 12 Likert-scale items (A Lot, Some, Very Little, or Not at All) on the survey asked participants to indicate the extent to which MS BEST Robotics Competition helped them learn or strengthen their skills in 12 areas. The results of data analysis revealed that on average, the participants perceived that the competition had helped them develop or strengthen their skills in all 12 areas to some extent. The area with the lowest average extent of improvement was that

of making a presentation in front of people that they did not know. The average score for this item was 2.87, indicating some help was obtained. Nevertheless, the mode for each item in this section was 4, indicating that MS BEST Robotics Competition had provided a lot of help in developing or strengthening their skills. Most noteworthy was the finding that indicated that 61% of the participants perceived that the MS BEST Robotics Competition had helped them in getting along with other students, co-workers, teachers, and supervisors. Table 32 display the results for this series of data.

Table 32: Descriptive Statistics of MS BEST Robotics Help

To what extent has MS BEST Robotics helped you learn or strengthen the following skills?	n	Mean	Mode
Listen and respond to other people's suggestions or concerns.	411	3.47	4
Talk with people to get the information you need.	411	3.5	4
Stop or decrease conflicts between people.	403	3.04	3
Get along with other students, co-workers, teachers, and supervisors.	408	3.53	4
Learn new ways of thinking or acting from other people.	410	3.41	4
Solve unexpected problems or find new or better ways to do things.	407	3.4	4
Weigh different issues and possibilities before making a decision.	411	3.36	4
Know how to gather and analyze information from different sources.	408	3.37	4
Work within the rules of a new organization or team.	409	3.49	4
Manage your time when you are under pressure.	405	3.35	4
Use practical math skills, such as graphs, tables, or estimating costs.	410	3	4
Make a presentation in front of people that you do not know.	411	2.87	4

Descriptive statistics was used to analyze the difference between help in the MS BEST Robotics program and gender. There was no major difference in the participants' receiving help based on gender based on the responses to the survey items. Table 33 list the results.

Table 33: Descriptive Statistics of MS BEST Robotics Help by gender

MS BEST Robotics Help	Gender	n	Mean	Std. Deviation
Listen and respond to other people's suggestions or concerns.	Female	140	1.514	0.662
	Male	266	1.583	0.764
	Total	406	1.559	0.730
Talk with people to get the information you need.	Female	140	1.443	0.649
	Male	266	1.571	0.780
	Total	406	1.527	0.739
Stop or decrease conflicts between people	Female	139	1.878	0.872
	Male	259	2.042	0.925
	Total	398	1.985	0.909
Get along with other students, co-workers, teachers, and supervisors.	Female	139	1.403	0.678
	Male	264	1.549	0.764

	Total	403	1.499	0.738
Solve unexpected problems or find new or better ways to do things.	Female	138	1.565	0.672
	Male	264	1.652	0.827
	Total	402	1.622	0.778
Weigh different issues and possibilities before making a decision.	Female	140	1.6	0.728
	Male	266	1.703	0.868
	Total	406	1.667	0.823
Know how to gather and analyze information from different sources.	Female	140	1.679	0.780
	Male	263	1.639	0.817
	Total	403	1.653	0.803
Work within the rules of a new organization or team.	Female	141	1.525	0.693
	Male	263	1.536	0.775
	Total	404	1.532	0.747
Manage your time when you are under pressure.	Female	138	1.645	0.753
	Male	262	1.683	0.864
	Total	400	1.67	0.826
Use practical math skills, such as graphs, tables, or estimating costs.	Female	140	2.021	1.089
	Male	265	2.087	1.046
	Total	405	2.064	1.061
Make a presentation in front of people that you do not know	Female	140	2.05	1.134
	Male	266	2.263	1.119
	Total	406	2.19	1.127
Learn new ways of thinking or acting from other people.	Female	139	1.48	0.663
	Male	266	1.68	0.881
	Total	405	1.61	0.817

conclusion

The MS BEST program is providing a strong foundation for middle and high school students to enter into STEM disciplines post program participation. It should also be noted from the demographics that there is still a need in the state of Mississippi to increase minority participation in robotics competitions. Participants' of MS BEST noted that their academic proficiency along with their foundation in research, computation, technical and engineering design capabilities increased at the conclusion of the competition. Over 82% of the participants had learned new transferable skills in STEM viable to the STEM workforce. More middle school students aspired to attain PhD's and professional degrees such as MBA's and JD's. On average, more females aspired to attain advanced degrees compared to males. More males, on average aspired to help younger males learn math and science.

As a result of empowering, challenging, encouraging, inspiring, exciting, and assisting in coordinating the MS BEST program, past participants, students, coaches, mentors and industry representatives, overall, felt that their involvement with MS BEST was quite rewarding. As a result of serving as mentors, more industry partners stated that they would like to be more

involved in the junior and high school throughout the academic year to ensure that students are learning the transferable skills necessary for the STEM workforce.

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