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Schuff, Sean L. ***An Analysis of the Impact of Concurrent Participation in a Charter School and a Related After-School Activity on Student Academic Achievement and Post-Secondary Completion Rates***

Abstract

STEM (Science, Technology, Engineering and Math) education opportunities for secondary students have gained momentum, as have related after-school learning opportunities such as competitive robotics teams. This study examined the academic achievement and post-secondary impact on students who graduated from a STEM charter school in Northeast Wisconsin who also spent four years on an after-school robotics team as compared to graduates from a traditional school. Grade point average during high school and post-secondary intentions were compared among different groups of students. Demographic differences related to gender and socioeconomic status were also explored.

The results showed increased GPA achievement among graduates of the charter school who also participated on the robotics team for four years. These same individuals were also more likely to have a post-secondary plan with a high percentage choosing a two- or four-year college path. The study also indicated differences in gender participation rates and socioeconomic status as measured by free and reduced lunch program participation. Even with a smaller sample size for several groups, the results indicated there is higher GPA achievement and stronger post-secondary intentions among those who graduated from the charter and participated for four years on the robotics team compared to those who did not.

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Acknowledgments

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Chapter I: Introduction

The first law authorizing the formation of charter schools was passed in Minnesota in 1991, providing a structural and substantive alternative to the traditional public school (Schroeder, 2004). A charter school is a non-sectarian, public school established by a charter or contract between teachers, parents, or community groups and a local or state authority, that operates the school without most local and state educational regulations, in exchange for increased accountability (Wisconsin Department of Public Instruction, 2018b). Wisconsin's Department of Public Instruction (2018b) sums up this increased freedom and flexibility for an expectation of improved student performance as "Autonomy for Accountability."

Charter schools have grown in number and size since the first charter law was passed in 1991 (Peterson, 2009). Their formation followed less than a decade after the report, *A Nation at Risk*, which warned "the educational foundations of our society are presently being eroded by a rising tide of mediocrity" (National Commission on Excellence in Education, 1983). Their popularity is founded on several key factors including the ability to remediate quickly, focused learning that teaches subjects contextually in engaging ways, providing a choice for parents and students, and educator freedom which fosters enthusiasm and innovation (Finne, 2016).

As of 2018, over 7,000 charter schools were present in 43 states and the District of Columbia, serving 3.2 million students (David & Hesla, 2018). Many of these charters provide students and parents an alternative to the traditional public school, utilizing non-traditional learning environments that extend the school day or academic year, partnering with local colleges and universities for student coursework, providing independent study opportunities, or focusing on specific career fields (National Alliance for Public Charter Schools, 2018). While the impact of charter schools on student achievement is still a matter for debate, the growth of

charters over the past quarter century shows there is demand for this alternative to the traditional school.

Dovetailing with the growth of charter schools is the expansion of STEM (Science, Technology, Engineering and Math) education across the country (Missouri Department of Elementary and Secondary Education, 2014; Schaffhauser, 2016). Project Lead The Way (PLTW), a leading STEM curriculum development and training non-profit, recently realized a 30% annual increase in the number of schools offering their programs (PLTW, 2014). These schools and programs are feeding the nation's need for employees in a field that has seen six times the growth in employment demand as compared to non-STEM fields (Noonan, 2017).

Alongside the expansion of charter schools and STEM education, robotics programs in our schools are also seeing considerable growth. After just ten years of existence, the VEX Robotics Competition serves over one million students on 16,000 teams in 40 different countries (VEX, 2018). Likewise, the FIRST family of robotics programs engages over 500,000 K-12 students with 150,000 adult mentors on nearly 60,000 teams worldwide (FIRST, 2018b). The positive impact of these programs on our nation's need for STEM talent is significant with over 75% of alumni of the FIRST program either actively seeking a degree in, or already a professional in, a STEM field (FIRST, 2018d).

Tesla Engineering Charter School (Tesla) in Appleton, Wisconsin is one of those career-focused schools, a STEM-based charter school developed in the winter of 2001 and opened in Fall, 2002. Tesla was formed as the result of the convergence of efforts of the Appleton Area School District, the Fox Cities Chamber of Commerce and Industry and their Alliance for Education, and the desire to bring the learning and experiences of the after-school robotics team into the school-day classroom (Mekash, 2001). Business and education leaders identified a need

and opportunity in providing a focused STEM education for students in the community to meet the demand of high-skill, high-wage occupations (Fox Cities Engineering Charter School, 2001, November 14). AASD educators were in the process of upgrading the engineering curriculum and recognized an opportunity to infuse the practical, design-based activities of the robotics team into the curriculum redesign.

The after-school robotics team that served as one of the catalysts for the formation of Tesla was the NEW Apple Corps FIRST Robotics Team (NEW Apple Corps, NAC). At the time, the NEW Apple Corps had been in existence for six years and consisted of 22 students and 8 engineering mentors who all participated in the FIRST Robotics Competition (NEW Apple Corps, 2018). This annual competition challenges teams with developing a custom-designed, purpose-built robot to compete in that year's regional and national events. Each year there is a new challenge and a new opportunity for students to engage in problem-solving, mechanical design, fabrication, electronic assembly, and programming for a new and unique robot (FIRST, 2018a). The team was and continues to serve as a practical after-school application of the classroom STEM instruction that takes place during the day in Tesla.

Tesla has seen positive results in preparing students for their pursuit of a degree leading to a career in the field of STEM. For the past four academic years, Tesla has ranked first or second overall in high schools in the state of Wisconsin according to the Department of Public Instruction's School Report Card (Wisconsin Department of Public Instruction, 2018c). Additionally, a recent review of graduation and Student Tracker data has revealed that 100% of students who graduate from Tesla have a post-secondary plan in place and for those graduates who attend a four-year college or university, 88% complete a degree in their intended field of study within six years (Appleton Area School District, 2015).

Statement of the Problem

Tesla leaders and teachers have only small samples of data on Tesla student post-secondary achievement, as mentioned above, and anecdotal evidence of their students' success, both during their time in high school and in their post-secondary planning and follow-through. Likewise, teachers and mentors on the NEW Apple Corps understand they are in a position to positively influence students in their post-secondary pursuits. However, there is no concrete, data-supported understanding of the impact of concurrent enrollment in Tesla and participation on the NEW Apple Corps Robotics Team as it compares to those who only participate in one or the other, or neither. There is historical cross-pollination of student experiences reflected in the fact that 79.2%, or 76 out of 96, of the current students on the robotics team also enrolled in Tesla. Seven years of Tesla alumni who were also four-year members of the robotics team will be the focus of this study in comparison to their counterparts who are involved in only Tesla or the robotics team, or neither.

Purpose of the Study

The purpose of this research study was to understand the combined impact of enrollment in Tesla and participation on the NEW Apple Corps Robotics Team and determine if there was a difference in the secondary academic achievement and college completion rates of those students who participate in and complete both Tesla and the NAC versus those who only participate in one or the other or neither. The research sought to answer the following questions:

1. What relationship does Tesla/NAC completion have on student academic success in high school measured by GPA and ACT scores?
2. What relationship does Tesla/NAC completion have on post-secondary completion rates?

3. How does student achievement compare between students who engage in complete participation in both Tesla and the NAC and those who participate in only one or the other, or neither.

Importance of the Study

Answering these questions and developing an overall understanding of the combined relationship of Tesla enrollment and robotics team participation on student academic performance and college completion will provide an incentive for other schools and districts to consider the addition of both a STEM program and a competitive robotics team that are implemented and executed in tandem with one another. There is currently anecdotal evidence, based on casual conversations with students and parents, that provides insight into the impact of concurrent participation in both Tesla and the robotics team. However, there is little, if any, empirical evidence that indicates the relationship between participation and academic outcomes. This quantitative study provides the evidence necessary to draw valid conclusions with the potential for an additional follow-up qualitative study to provide context and color at a later date.

On a local level, the results provide Tesla leadership and staff, and robotics team mentors with an understanding of the extent to which concurrent participation in Tesla and the robotics team influences students' academic performance in high school and their completion of post-secondary coursework in preparation for their future careers. The data collected has the potential to inform future studies of the impact Tesla and the robotics team has on students and help guide future decisions related to the school and the robotics team.

Finally, this research adds to the overall general body of knowledge regarding the influences that play a part in student secondary and post-secondary success. The results have the potential to verify or expand upon existing knowledge related to this area. Adding to the general

body of knowledge aligns with the Data Quality Initiative of the Association for Career and Technical Education (ACTE) (ACTE, 2018). One of the issues of focus in ACTE's Policy Agenda is the desire to collect and disseminate high-quality CTE-related data across different agencies.

Assumptions of the Study

Three key assumptions have been made during this study.

1. There is a difference between Tesla/NAC completers and those who do not complete both.
2. Access to the necessary historical data will be provided by the AASD.
3. Sufficient data is available to inform the study and draw logical conclusions.

Definition of Terms

The definitions listed below provide a common vocabulary for both the researcher and the reader as they relate to the research being conducted.

Academic and Career Plan/Planning (ACP). "A student-driven, adult-supported process in which students create and cultivate their own unique and information-based visions for post-secondary success, obtained through self-exploration, career exploration, and the development of career management and planning skills" (Wisconsin Department of Public Instruction, 2018a).

Completion/Completer. For the purposes of this study, the terms completion and completer relate to students who have completed the requirements for graduation from Tesla Engineering Charter School or have participated in the NEW Apple Corps Robotics Team for all four years of high school.

Post-secondary completer. Students who complete a post-secondary degree within six years of graduating from high school.

Post-secondary plans/planning. Options students can choose after high school graduation including direct employment, apprenticeships, military service, two-year technical colleges, two-year community colleges, and four-year colleges/universities.

Related after-school experience. For the purpose of this study, the term related after-school experience will refer to those after-school experiences and opportunities students have that are directly related to their academic pursuits in school.

Science, Technology, Engineering and Math (STEM). An acronym used to describe the fields of science, technology, engineering, and mathematics and their interrelated nature in both academics and the private sector.

Student achievement. For this study, student achievement will be defined as student performance measured by grade point average (GPA) and ACT score.

Limitations of the Research

The research proposed has the following limitations:

1. The research is conducted on a single STEM charter school and robotics team in a single district, which may or may not generalize to other schools with similar programs.
2. The research does not take into consideration the overall demographics of the Appleton community and how these demographics compare to other more urban or rural communities.
3. Tesla Engineering Charter School and how it is structured may be unique and different than other charter schools or STEM-focused schools.

Chapter II: Literature Review

Tesla Engineering Charter School and the NEW Apple Corps FIRST Robotics Team are in their 16th and 22nd years of existence, respectively, and there is much to learn about the impact of these two organizations on the students who participate in them. The purpose of this study was to identify the relationship, if any, concurrent enrollment in Tesla Engineering Charter School and participation on the NEW Apple Corps Robotics Team has on student achievement and post-secondary completion and compare the data to related data for AASD students involved in one or the other or neither.

Included below is a discussion of the history and evolution of charter schools and the impact they have had on student achievement, a history of Tesla Engineering Charter School and the NEW Apple Corps, and a discussion of the research related to after-school programs and Career and Technical Student Organizations (CTSO's) and their role in student success. Each of these provide a foundation and reference point for this research.

History and Evolution of Charter Schools

The ancestral origins of charter schools, or more broadly, school choice, dates back hundreds of years to colonial America and the work of John Stuart Mill and his contention that public schools should provide educational options to families (Finn & Wright, 2017). However, it wasn't until Milton Friedman published *Capitalism and Freedom* in 1962 that school choice began to be seriously considered (Smith, 2012). Both Mill and Friedman believed in what is now known as school choice, but they had different ideas about why it was important with Mill believing in freedom of thought and Friedman believing in the power of competition in the educational marketplace (Smith, 2012).

Just two short decades after Friedman's work, the educational alarm bells were rung with *A Nation at Risk*, a report from then President Reagan's National Commission on Excellence in Education. The report warned of a deteriorating educational system in the United States that required immediate and decisive action. Gathering data from business, industry, educational institutions, and the United States military, the commission warned that the nation was already on a slippery slope and would soon be, if it was not already, out-performed by other countries in technological innovation, manufacturing ability, and educational attainment (National Commission on Excellence in Education, 1983). The report made headlines however, substantive change would not take place until nearly a decade later.

While their motives may have been different, the impact of Mill and Friedman's work, coupled with the warnings of *A Nation at* Risk, was finally realized in 1991 with the passing of the first charter school law in Minnesota (Schroeder, 2004). The first charter school to open its doors following the passage of Minnesota's law was St. Paul's City Academy Charter School in 1992 (Jacobs, 2015). The school was formed to serve at-risk students who were in danger of not graduating or were from families that struggled with poverty and substance abuse. Just four years later, the Appleton Area School District added their own at-risk charter school with Appleton Central, an alternative high school for students who are significantly credit deficient (Appleton Central, 2018).

As the number of charter schools expanded since the early 1990's, so has their focus. Moving beyond the role of serving students considered to be at-risk, charters have expanded their focus and delivery, offering career-based learning opportunities (Tesla Engineering Charter School, 2018, Pathways Charter School, 2018), engaging students in project-based learning experiences (Minnesota New Country School, 2018; Valley New School, 2018) providing online

learning environments (Florida Virtual School, 2018; Wisconsin Connections Academy, 2018) and utilizing different models of instruction such as the Classical Method and the Montessori Method (Classical Charter Schools, 2018; Alliance Charter School, 2018).

The growth of charters has been significant over the last quarter century, expanding from one school with 36 students (Jacobs, 2015) to over 7,000 schools serving 3.2 million students (David & Hesla, 2018). However, expansion and opportunity do not always equate to improvement. Providing educational choice to families should not come at the expense of student academic performance and future opportunity.

Impact of Charter Schools on Student Achievement

In the years since the first charter law passed, charter schools have evolved to provide a focus of some sort, whether it be the arts, technology, the environment, a project-based theme, or any number of other areas. These small learning communities are similar to efforts of colleges and universities to establish communities of learners who are focusing on shared knowledge, shared knowing, and shared responsibility (Tinto, 2003). Of the roughly 7,000 charter schools in existence today, nearly one-fifth of them have a focus on STEM (Science, Technology, Engineering and Mathematics) or an area closely related such as robotics, software development, or design (National Alliance for Public Charter Schools, 2018). These charter schools provide an education tied to a specific career field; one that is both lucrative and in demand (Bureau of Labor Statistics, 2018). With the recent implementation of Academic and Career Planning (ACP) in Wisconsin, career-focused charter schools have a potential head start in providing career exploration and advisement to their students.

Numerous studies have been conducted on charter schools in the years since the first charter law was established in 1991, with some studies finding mixed results in academic

achievement including grade point average (GPA), test scores, and graduation rates (Booker, Gilpatric, Gronberg, & Jansen, 2007; Buddin & Zimmer, 2005; Clark, Gleason, Tuttle, & Silverberg, 2015), and others finding positive results in academic achievement (Hung, Badejo, & Bennett, 2014; Zimmer et al., 2009). For example, Gronberg & Jansen (2005) found that students in charter schools performed at a lower level in math and reading on the Texas Assessment of Knowledge and Skills (TAKS) exam compared to their traditional public-school counterparts (p. 20). However, Greene, Forster, and Winters (2003) researched a cross-section of schools across 11 states and found there was a statistically significant, albeit modest two to three percent improvement in reading and math scores, respectively, between charter school students and their traditional school counterparts (p. 8).

There are also differences in the graduation rates at the secondary and post-secondary level when comparing charter school students to their public-school counterparts. Charter school students are 7 to 11 percent more likely to graduate from high school (Sass, Zimmer, Gill, & Booker, 2016). And, according to an analysis of nine large charter school networks serving at-risk youth, their college completion rates are three to five times the national average when compared to at-risk youth in the traditional public school (Whitmire, 2017). This analysis looked solely at those charter schools that served at-risk populations which, while representative of the majority of charter schools across the nation, may not reflect all charter schools. Research and data on the academic achievement, secondary graduation rates, and post-secondary completion rates of students in other types of charter schools, such as STEM-based schools, was found to be lacking after an extensive search of the literature.

All these authors agreed it was difficult to compare charters amongst themselves and to traditional public schools due to the wide variety of charter policies adopted by states and local

educational agencies (Zimmer et al., 2012) and the self-selecting nature of charter school students (Ni & Rorrer, 2012). Additionally, research suggests that charter schools evolve over time and to compare charters in their early years to more established traditional schools is tantamount to comparing apples to oranges (Buddin & Zimmer, 2005; Jacob, 2017; Ni & Rorrer, 2012). Fortunately, Tesla Engineering Charter School has been in existence for sixteen years and has a long enough history to consider it a "well established" charter school.

History and Evolution of Tesla Engineering Charter School

Tesla Engineering Charter School was founded in Appleton, Wisconsin by local business and industry leaders working in collaboration with administrators and educators from the Appleton Area School District. Both groups of individuals recognized two key, inter-related issues that needed to be addressed with the new school. First, there was and continues to be a need for a high-skill, high-wage, high-tech workforce in the Fox Valley region of Northeast Wisconsin. According to Wisconsin's WORKnet data, for the ten-year period from 2014 to 2024, overall employment growth in engineering occupations in Wisconsin is projected to be 8.25%, with the top five engineering disciplines growing at an average of 15.7% (Wisconsin's WORKnet, 2014). The demand for new employees with engineering degrees in a variety of disciplines has been and continues to be a concern for employers across the state and in the Fox Valley.

Second, while Wisconsin is not experiencing a "brain drain", per se, the state is also not benefiting from "brain gain" either. According to Deller, Conroy, and Kures, (2018) Wisconsin does not experience substantial out-migration of individuals with a bachelor's degree or higher which indicates that the state is retaining many of its citizens who were born, raised, and educated in Wisconsin. However, the state has a lack of "brain gain" which means that while

Wisconsin is retaining a large percentage of its most educated citizens, it is still realizing a net loss in highly skilled workers (Deller, Conroy, & Kures, 2018). It is this trend of net migration out of the state and the Fox Valley that the founders and supports of Tesla were attempting to mitigate.

The result of the desire to reverse the trend of net loss of a high-skilled workforce in the Fox Valley led to the exploration and development of Tesla Engineering Charter School. Tesla's mission is "to integrate a broad exposure to the field of engineering and technology with a balanced high school experience, and to prepare those with the aptitude and passion to pursue post-secondary education and careers in science, technology, engineering and math" (Tesla Engineering Charter School, 2018). With the NEW Apple Corps Robotics Team well established in the district, the desire of staff to continue the evolution of the engineering curriculum within the school, and the support and encouragement of local business and industry leaders, Tesla was the appropriate secondary education solution for addressing the employment needs of the Fox Valley.

Small Learning Communities and a Focused Learning Environment

Tesla Engineering Charter School has two key traits that set it apart from a traditional high school: it is a small learning community of approximately 130 students in grades 9 - 12, and it focuses on a specific course of study, namely STEM education. According to Tinto (2003), in many schools, "students typically take courses as detached, individual units, one course separated from another in both content and peer group, one set of understandings unrelated in any intentional fashion to what is learned in other courses" (p. 1). This disconnect between and among academic subjects creates an environment where it is up to the student to form the connections between their English class and their math class; between their science class and

their history class. Additionally, students are typically not placed as a cohort in their respective classes. The peers of a particular student in a geometry class will likely be different than those they have in a history class which will likely be different from those in their chemistry class. Students are learning different concepts at different times with different peers with very little continuity throughout the school day (Tinto, 2003).

The traditional comprehensive high school has been likened to a mass-production, assembly line philosophy of education, panned for "their impersonal structures, fragmented curricula, segregated and unequal program options, and inability to respond effectively to student needs" (p.163) (Darling-Hammond, Ross, & Milliken, 2006). Learning communities, on the other hand, enable students to take courses together within a common schedule, oftentimes based on shared interest.

Learning communities are groups of students learning as a cohort, typically with a common structure or focus. Zhao and Kuh (2004) characterize learning communities as educational endeavors that "incorporate active and collaborative learning activities and promote involvement in complementary academic and social activities that extend beyond the classroom" (p. 116). Learning communities provide the opportunity for students, staff, and curricula to come together in a focused cohort of learners and teachers. As Tinto points out, learning communities are not a "magic bullet" for student success, but there is evidence that the implementation of learning communities enhances student learning in school (Tinto, 2003).

While the research of Zhao and Kuh (2004) focused on a broad definition of student success in learning communities, including engagement and overall satisfaction, they indicate there is a negative or non-existent correlation between participation in a learning community and student academic performance (Zhao & Kuh, 2004). In other words, those students who

participated in a learning community performed at or slightly below their non-community counterparts, at least at the outset of their experience. In the end, however, senior level students all performed at the same level and those who were placed in a learning community had more positive experiences including those related to integration of social and academic experiences, improvements in skill, competence, and knowledge, and overall academic satisfaction (Zhao & Kuh, 2004).

Extended Learning Through Student Organizations and After-School Programs

Similar to the results of research conducted on charter schools, research that examined the impact of after-school programs also indicated mixed results. Little, Wimer, and Weiss (2007) indicated that when it comes to after-school programming, "not all research and evaluation studies have shown benefits" (Darling-Hammond, Ross, & Milliken, 2006, p. 163). However, they go on to indicate that for many programs, there are positive outcomes including a better attitude toward school, at both the primary and secondary levels, increased aspirations for higher education, and better academic performance in school. Regardless of their impact, after-school programs have been growing and continue to grow at a significant pace over the past two decades (David, 2011).

What is most relevant to the research study being conducted here is the challenge to the assumption that after-school programs will increase student achievement if it is tied to topics and activities in the classroom (David, 2011). Yaffe (2016) argues that the most impactful after-school programs are tied closely to instruction that takes place during the day. This interconnectedness is precisely what is occurring in the partnership between Tesla and the NEW Apple Corps.

One other dynamic of the impact of after-school programming is with regards to consistent and sustained participation. Connections to the classroom, community partnerships, and, more importantly, steady participation during the year and from year to year are necessary to achieve positive outcomes (Little et al., 2007). According to David (2011), students who participate in after-school programs for two or more years show improvements in a variety of areas, including, surprisingly, mathematics, even when math was not an emphasis of the program. Programs can also impact other less academic skills such as teamwork and empathy (Yaffe, 2016).

Career and technical student organizations. After-school opportunities for high school students can also be found through involvement in Career and Technical Student Organizations. According to the National Coordinating Council for Career and Technical Student Organizations (2018) CTSO's "enhance student learning through contextual instruction, leadership and personal development, applied learning, and real-world application." CTSO's are an exception to the varied research results of other co-curricular activities. Over 2 million students are engaged in CTSO's nationwide with many showing higher academic achievement, a focused interest in a career field, and a higher level of employability skills than their non-CTSO counterparts (National Coordinating Council for Career and Technical Student Organizations, 2018). Over 41,000 students in the state of Wisconsin participate in a CTSO, gaining valuable insights into their local community and businesses which helps them develop a pathway through high school, into post-secondary education, and into a career (NCCfCTSO, 2018).

DECA, a business and marketing CTSO provides positive results for students engaged in a local chapter. With membership totaling over 235,000 students in 5,300 chapters, 94% of these

members report an “A” or “B” average, and 91% report that their experiences in DECA have had an impact on their future career pursuits (DECA, 2017).

SkillsUSA, the Technology and Engineering Education counterpart to DECA, has also seen positive results for its 335,000 student participants. SkillsUSA members report that concurrent enrollment in a CTE course and participation in a CTSO, specifically SkillsUSA, results in an improved grade point average and a clearer career path (SkillsUSA, 2016). In addition, to the academic and career path impact SkillsUSA has on students, over 80% of participants indicated that the organization connected their academics to the real world, helped them develop 21st century skills, and built their leadership abilities.

Overall, CTSO’s provide a positive impact on the academic achievement, behavior, and social awareness of students (Guest & Schneider, 2003). In addition, the competitive element of CTSO’s provides the greatest impact on students in other areas including academic engagement, career self-efficacy, and college aspirations (Alfeld, Hansen, Aragon, & Stone, 2006). Finally, CTSO’s provide college and career readiness at a higher level than that found in those students who do not participate in these organizations (Decker, 2012). Evidence from CTSO’s shows student academic gains for participants and that is what will be explored in this research, specifically as it relates to Tesla Engineering Charter School and the NEW Apple Corps Robotics Team.

History and overview of FIRST Robotics. Conceived of and formed by inventor Dean Kamen, FIRST hosted its inaugural robotics competition with 28 high school teams in a New Hampshire gymnasium in 1992. Since that time, FIRST has expanded beyond a high school-aged competition to include four programs attracting over 400,000 students in K-12 from around the globe with the goal of inspiring young people to tackle the toughest challenges of our

generation and "build a brighter future" (FIRST, 2018c). The mission of FIRST is to "inspire young people to be science and technology leaders and innovators, by engaging them in exciting mentor-based programs that build science, engineering, and technology skills, that inspire innovation, and that foster well-rounded life capabilities including self-confidence, communication, and leadership" (FIRST, 2018e). The impact of FIRST experiences on student interest in STEM careers is significant with consistent FIRST participants being 2.3 times more likely to show interest in STEM careers than their one-time participant counterparts (Melchior, Burack, Hoover, & Marcus, 2017).

In 1996, the Appleton Area School District (AASD) in Appleton, Wisconsin partnered with Boldt Construction and Lawrence University to form a FIRST Robotics team for the 1997 competition season. The team grew to about 25 students and 15 mentors and competed in both regional and national competitions. Today the team consists of nearly 100 students from the Appleton Area School District and 30 mentors from local business and industry. Additional sponsoring partners have been brought on board including Plexus Corp., Baisch Engineering, Miller Electric Manufacturing, and ValMet. Students and mentors work together to build a 5-foot-tall, 150-pound competition robot in just six weeks. Through the process, students learn valuable technical and business skills while also gaining career insights by working side-by-side with mentors from the community.

Underlying Theory

Two key theories that play a part in this research are Dewey's theory of experience in the process of learning and Piaget's theory of cognitive development through experience. According to Glassman (2001), Dewey's view of experience in the context of learning requires that "vital experience" moves beyond simple rote memorization to activities that have educational worth.

Piaget's notion of constructivism and cognitive development theory encourages hands-on learning and contends that the adolescent stage of development involves young people envisioning their future (Blake & Pope, 2008).

In his book, *Experience and Education*, Dewey (1938) contends that experiences, beyond mere book work and rote memorization, should be a necessary element of public education. (Dewey, 1938). He refers to an "experiential continuum" that provides intellectual growth over time. Experiences, as Dewey contends, should give meaning to learning and assist individuals in developing a purpose. As Dewey's theories relate to this research, Tesla and the NEW Apple Corps endeavor to engage students in meaningful experiences that provide context for their classroom education and help them find a purpose for their future.

Constructivist theory argues that learners construct their knowledge through their own individual experiences (Grant, 2002). Project-based learning takes many of its cues from constructivist theory to allow students to take responsibility for their own learning. Piaget (1969) contends that students construct their own learning through their interactions with each other and their environment.

The combination of the academic classroom learning of Tesla classes coupled with the hands-on experiences on the robotics team fall within the realm of theories promoted by both Dewey and Piaget. Dewey's philosophy of learning by doing and Piaget's constructivist theory form many of the underpinnings of the learning opportunities for students found in Tesla and on the robotics team.

Summary

The literature supports the argument that small learning communities of students with similar interests, a learning environment that focuses on a specific learning style or career field,

and after-school learning experiences that are tied to school day coursework, such as CTSO's or robotics programs, all provide a positive impact to student academic achievement and post-secondary pursuits. And combining two or more of these elements is typical in charter schools. While the overall body of literature spanning the 25-year history of charters gives a mixed picture of their success, recent studies indicate an increase in the academic performance of charter school students as many of these schools come of age.

After-school robotics programs provide a wealth of opportunities for students with an interest in STEM fields and the literature bears out the positive outcomes associated with involvement in these organizations. Tesla has leveraged STEM-focused after-school programs to provide practical application of the classroom STEM concepts students are learning during the day.

Chapter III: Methodology

Understanding the relationship between student involvement in related co-curricular activities and participation in a focused academic program has the potential to inform decision-making regarding implementation of these types of programs on a broader basis. There is no concrete, data-supported understanding of the impact of concurrent enrollment in Tesla Engineering Charter School and participation on the NEW Apple Corps Robotics Team as it compares to those who only participate in one or the other, or neither. Seven years of Tesla alumni who were also four-year members of the robotics team were the focus of this study in comparison to their counterparts who were involved in only Tesla or the robotics team, or neither.

The purpose of this research study was to understand the combined impact of enrollment in Tesla and participation on the NEW Apple Corps (NAC) Robotics Team and determine if there is a gap in the secondary academic achievement and college completion rates of those students who participate in and complete both Tesla and the NAC versus those who only participate in one or the other or neither. The research seeks to answer the following questions:

1. What relationship does Tesla/NAC completion have on student academic success in high school measured by GPA and ACT scores?
2. What relationship does Tesla/NAC completion have on post-secondary completion rates?
3. How does student achievement compare between students who engage in complete participation in both Tesla and the NAC and those who participate in only one or the other, or neither.

Subject Selection and Description

The subjects selected for this study were alumni students of the Appleton Area School District. Due to the focused nature of this study, data for all student categories identified below was collected and analyzed. The four groups of students that constituted the subjects of this study consist of the following:

1. Tesla and robotics (Tesla/NAC) completers defined as AASD alumni who have completed the graduation requirements for Tesla Engineering Charter School and have participated on the NEW Apple Corps Robotics Team for four years.
2. Tesla Engineering Charter School participants defined as AASD alumni who have completed at least one year of Tesla coursework but did not meet the graduation requirements of the school and did not participate on the NEW Apple Corps Robotics Team.
3. NEW Apple Corps Robotics Team participants defined as AASD alumni who have participated in at least one but not more than three years on the robotics team and were not enrolled in Tesla Engineering Charter School.
4. Appleton East High School graduates defined as AASD alumni who graduated from Appleton East High School but did not participate in Tesla Engineering Charter School or the NEW Apple Corps Robotics Team.

Research Design

Descriptive studies provide analysis of data trends of a single variable across multiple groups (Creswell, 2012). This study relied on ex-post facto data collection of academic records of students who fell into the four groups defined above. Analysis of the data used a descriptive approach, relying on a comparison across the four groups, analyzing variability among the data

sets identified below. Mean, median, and mode statistics provided an understanding of the central tendency of the data for each group, and range and standard deviation provided an understanding of the variability among the data. Comparisons of individual data points (grade point average, ACT score, college completion) occurred between each of the student groups to determine if there was a performance gap between groups, and to what extent these performance gaps exist.

Data Collection Methods

Group populations and/or descriptions were provided to the Appleton Area School District's Assessment, Curriculum, and Instruction (AC&I) department and the Information Technology Services department for data retrieval. The data collected was anonymized in order to maintain student privacy and confidentiality and was provided to this author in a spreadsheet format to aid in analysis.

Specific data to be collected included the following:

1. Group affiliation based on the four categories of students identified above.
2. Gender of the student
3. Graduation year of the student
4. Student eligibility for free and reduced lunch
5. Cumulative grade point average of the student at time of graduation
6. ACT score of the student
7. Post-secondary enrollment of the student based on Student Tracker data
8. Post-secondary completion of the student based on Student Tracker data

Data Analysis

Data analysis consisted of taking the four groups identified and the various variables associated with them and comparing them across groups using the established criteria. Basic descriptive statistics of mean, median, mode and standard deviation were used to compare each of the four groups between themselves. A matrix was used to compare the results for each of the established criteria. Post-secondary comparisons were made separately from the other criteria identified above.

Limitations

As with any study, there are certain limitations that impact the study results and this study was no exception. As technology advances and student information system platforms change, transition of legacy data to new systems sometimes compromises the integrity of the data. In addition, human error in accessing and providing the appropriate data can also impact data accuracy. There have been known issues with data accuracy in the past which may skew some of the results of this research. Future studies related to this topic will either refute or corroborate the findings presented below. One final limitation was the pool of students being studied. The Appleton Area School District is home to three traditional high schools and five charter schools at the secondary level. The majority of students enrolled in Tesla and participating on the robotics team would be Appleton East High School students if Tesla and the robotics team did not exist. However, the demographic and academic statistics for Appleton East High School students are similar to those of the other two traditional high schools and the district as a whole.

Chapter IV: Results

This study sought to identify the impact, if any, completion of Tesla Engineering Charter School and four-year participation on the NEW Apple Corps Robotics Team had on student academic achievement and post-secondary completion as compared to their counterparts in Appleton East High School who only participated in Tesla or the robotics team or did not participate in either. The data collected was intended to answer the following research questions:

1. What relationship does Tesla/NAC completion have on student academic success in high school measured by GPA and ACT scores?
2. What relationship does Tesla/NAC completion have on post-secondary completion rates?
3. How does student achievement compare between students who engage in complete participation in both Tesla and the NAC and those who participate in only one or the other, or neither.

The results provided in this chapter include the basic demographics of the subject population and an overview and analysis of each of the research questions listed above based on the data collected.

Demographics

The subjects selected for this study consisted of 1,456 alumni students of Appleton East High School and Tesla Engineering Charter School who graduated during the four-year period of 2015 to 2018. The initial goal of this study was to gather data going back seven years to provide a larger sample size and opportunity to observe post-secondary completion; however, due to data access limitations, only four years of data was available. The students were divided into four groups for the purpose of this study, consisting of the following:

1. Tesla and robotics completers defined as AASD alumni who have completed the graduation requirements for Tesla Engineering Charter School (Tesla) and have participated on the NEW Apple Corps Robotics Team (NAC) for four years (Tesla/NAC completers).
2. Tesla Engineering Charter School participants defined as AASD alumni who have completed at least two years of Tesla coursework but did not meet the graduation requirements of the school and did not participate on the NEW Apple Corps Robotics Team (Tesla participants).
3. NEW Apple Corps Robotics Team participants defined as AASD alumni who have participated in at least one but not more than three years on the robotics team and were not enrolled in Tesla Engineering Charter School (NAC participants).
4. Appleton East High School graduates defined as AASD alumni who graduated from Appleton East High School but did not participate in Tesla Engineering Charter School or the NEW Apple Corps Robotics Team.

The overall group is nearly equally distributed among female and male students, consisting of 708 (48.6%) female students and 748 (51.4%) male students. Of the 1,456 students, 617 (42.38%) are eligible for the district's Free and Reduced Lunch (FRL) program. Both of these demographics were consistent with the overall Appleton Area School District population: district-wide, females make up 49.09% of the population while males make up 50.91% of the population, and 42.24% are eligible for the FRL program.

However, the demographics change when we look solely at Tesla/NAC completers. As can be seen in Table 1, Tesla/NAC completers are predominantly male, with female students representing only 19.05% of the completer population. It is worth noting that the percentage of

women pursuing post-secondary degrees in engineering is 21.4% nationally which is not much different than the percentage of female Tesla/NAC completers (Yoder, 2016). Likewise, the percentage of females enrolled in secondary STEM programs throughout the country is 21.1% (U.S. Department of Education, 2012). This indicates that gender demographics of Tesla/NAC completers are representative of the current enrollment demographics in post-secondary engineering education and high school STEM programs nationwide.

Table 1

Demographic Distribution by Gender

	Tesla/NAC Completers (n=42)	Tesla Participants (n=32)	NAC Participants (n=24)	Appleton East HS (n=1414)
Female	19.05%	9.38%	8.33%	49.50%
Male	80.95%	90.63%	91.67%	50.50%

Table 2 provides a look at the difference in FRL program eligibility among the different student groups. There is a substantially lower percentage of students (14.29%) eligible for the district's FRL program among Tesla/NAC completers compared to their Appleton East High School counterparts (43.21%). Tesla participants and NAC participants are also lower at 21.88% and 16.67% respectively. The percentage of FRL eligible students in the Appleton East population is similar to those eligible in the overall Appleton Area School District high school population (42.24%).

Table 2

Free and Reduced Lunch (FRL) Eligibility

	Tesla/NAC Completers (n=42)	Tesla Participants (n=32)	NAC Participants (n=24)	Appleton East HS (n=1414)
FRL Eligibility	14.29%	21.88%	16.67%	43.21%

Item Analysis

The first research question sought to answer what relationship Tesla/NAC completion had on student academic success in high school measured by GPA and ACT scores. ACT scores for the subjects of this study were not readily available and would have provided incomplete data, at best. Therefore, GPA is the primary data point for differentiation of academic performance among the groups in this study. When compared to academic performance for Appleton East High School students, Tesla/NAC completers showed higher achievement based on grade point average. As shown in Table 3, Tesla/NAC completers achieved GPA's of 0.602 points higher than their Appleton East counterparts. This represents a 15% difference in academic performance between the two groups. It is also worth noting that although demographics indicated lower female participation in Tesla/NAC, their cumulative GPA is higher (3.663) compared to their male counterparts (3.336). Additionally, 7.41% of Tesla/NAC completers over the four-year period graduated with a cumulative 4.0 GPA. This compares to 1.84% of Appleton East High School students graduating with a cumulative 4.0 GPA during the same period.

Table 3

Cumulative Grade Point Average

	Tesla/NAC Completers n=42	Appleton East HS n=1414
Average Cumulative GPA	3.418	2.816
Average Female GPA	3.663	2.822
Average Male GPA	3.336	2.810

The second research question sought to identify what relationship Tesla/NAC completion has on post-secondary completion rates. Due to the limited range of the data provided and the lack of access to post-secondary completion data of all students involved in this study, an accurate analysis of post-secondary completion was not possible. However, post-secondary intentions data was obtained and provides a starting point for future research involving post-secondary completion. Table 4 provides a comparison of post-secondary intentions of the subjects of this study. Tesla/NAC completers had a much higher tendency to pursue programs of study at four-year colleges and universities compared to students in the other three groups. Additionally, even those with some participation in either Tesla or the NEW Apple Corps had higher four-year post-secondary intentions than Appleton East graduates.

Table 4

Post-Secondary Intentions

	Tesla/NAC Completers (n=42)	Tesla Participants (n=32)	NAC Participants (n=24)	Appleton East HS (n=1414)
4-year college/ university	88.10%	53.13%	58.33%	45.05%
2-year vocational school	7.14%	43.75%	33.33%	21.00%
1-year technical diploma	0.00%	0.00%	0.00%	0.42%
Military	4.76%	0.00%	0.00%	1.70%
Undecided	0.00%	3.12%	8.34%	3.04%
Other	0.00%	0.00%	0.00%	4.46%
Unknown	0.00%	0.00%	0.00%	24.33%

Post-secondary intentions go beyond four-year colleges and universities. When students are included who have a plan for after graduation, including two-year vocational schools, the military, and other post-secondary options, the differences are even more pronounced. Students who indicated they had a plan for after high school graduation were 100% of Tesla/NAC completers, 96.88% of Tesla participants, and 91.66% of NAC participants (Table 5). These numbers are considerably higher than their Appleton East High School counterparts at 72.63%.

The final research question in this study sought to understand how academic achievement compared between students who completed both Tesla and the NAC and those who participated in only one or the other, or neither. This provides a comparison of academic achievement based on cumulative grade point average at the time of high school graduation. Tesla/NAC completers had a higher mean GPA than all other groups and a relatively smaller standard deviation indicating that many of the students within the group achieved a GPA close to the mean GPA. It

is interesting to note that out of all four groups, those who participated in Tesla but did not graduate from Tesla had the lowest mean GPA and the second highest standard deviation.

One point to note is the mode cumulative GPA of 4.000. While this may seem unlikely, there are 4,001 different combinations of GPA ranging from 0.000 to 4.000 when calculating out to the thousandths place, which is what was provided in the data. This result is consistent across all three traditional high schools in the AASD as well as the district as a whole.

Table 5

Cumulative Grade Point Average for All Groups

	Tesla/NAC Completers (n=42)	Tesla Participants (n=32)	NAC Participants (n=24)	Appleton East HS (n=1414)
Mean Cumulative GPA	3.418	2.792	3.086	2.816
Median Cumulative GPA	3.548	2.765	3.315	2.947
Mode Cumulative GPA	4.000	N/A*	N/A*	4.000
Standard Deviation of Cumulative GPA	0.526	0.835	0.735	0.870

* Due to the smaller sample size of the group, there was no mode cumulative GPA.

Chapter V: Discussion, Conclusions and Recommendations

Charter schools and after-school robotics programs have grown nationwide, and present opportunities to explore the impact these programs are having on student academic achievement and post-secondary intentions, especially when implemented in tandem. Tesla Engineering Charter School and the NEW Apple Corps have been in existence since 1997 and 2002 respectively, providing a combination of STEM education and after-school robotics experiences for students. While the school and robotics team are well-established, there has been no baseline data analyzed regarding these programs. A review of literature related to the impact of charter schools, small learning communities, focused learning environments, and after-school learning opportunities including Career and Technical Student Organizations suggests the positive impact these learning settings can have on student academic performance.

The goal of this study was to determine if there was a difference among groups of students based on two specific areas of achievement: secondary academic achievement and post-secondary completion. The groups of students were graduates of Tesla Engineering Charter School, a STEM-focused school; graduates of the NEW Apple Corps Robotics Team, an after-school FIRST robotics team; and graduates of Appleton East High School.

The data collected was intended to answer the following specific research questions:

1. What relationship does Tesla/NAC completion have on student academic success in high school measured by GPA and ACT scores?
2. What relationship does Tesla/NAC completion have on post-secondary completion rates?

3. How does student achievement compare between students who engage in complete participation in both Tesla and the NAC and those who participate in only one or the other, or neither.

The four groups in this study were sorted based on their involvement which included students who were graduates of Tesla Engineering Charter School and four-year completers of the NEW Apple Corps Robotics Team, students who participated in but did not complete four years in Tesla, students who participated in but did not complete four years on the robotics team, and students who are graduates of Appleton East High School and did not participate in either Tesla or the robotics team.

Methods used to conduct this study consisted of identifying the subjects of the study, gathering anonymous ex-post facto data on all of the subjects, and conducting a descriptive analysis of the data. The comparison of academic achievement was intended to be measured by cumulative GPA at graduation along with ACT scores. While GPA data was readily available for all students, substantially less data was available with regards to ACT score, therefore ACT score was left out of the analysis. Additionally, student anonymity would not have been possible with the current ACT data reporting process. Likewise, only post-secondary intention data was collected, with no post-secondary completion data readily available. The first and third research questions were answered, albeit with only the data point of GPA. The second research question of determining if there is a difference in post-secondary completion, was not met. However, conclusions can still be drawn from the post-secondary intentions data that was collected and analyzed. The analysis focused on gender, socioeconomic status based on Free and Reduced Lunch (FRL) program eligibility, average cumulative GPA at graduation, and post-secondary graduation intentions.

The remainder of this chapter will discuss the findings for each research question, establish conclusions based on an analysis of the data, and provide recommendations for future iterations of this study.

Discussion

It is clear that there is a difference in both demographics and academic achievement among the Tesla/NAC completers as compared to the other three groups in this study. FRL eligibility as a reflection of socioeconomic status may be a cause of the academic performance gap between the Tesla/NAC completers and the traditional Appleton East graduate. Studies have indicated that students who are enrolled in FRL programs tend to have lower academic achievement; however, these same studies indicate that other factors also play a part in lower academic achievement as well (Caldas & Bankston, 1997). FRL eligibility among Tesla/NAC completers is 1/3 that of Appleton East graduates. This indicates a Tesla/NAC completer population that likely has more resources available to them to support their academic needs.

There were also gender differences between the Tesla/NAC completers population, the participants populations, and the Appleton East High School population. The percentage of female students in the Tesla/NAC completers group was 19.05% while the percentage of female students in the Appleton East group was 49.50%. However, the percentage of females in the Tesla/NAC completer group are consistent with nationwide statistics of females enrolled in high school STEM programs (21.1%) (U.S. Department of Education, 2012) and post-secondary engineering education programs (21.4%) (Yoder, 2016). The percentage of females in the Tesla participants group and the NAC participants group were 9.38% and 8.33%, respectively, less than half the 21.1% of female students enrolled in high school STEM programs nationwide.

Research Question 1 sought to understand the relationship Tesla/NAC completion has on student academic success in high school measured by GPA and ACT scores. When compared to academic performance for Appleton East High School students (Mean GPA = 2.848), Tesla/NAC completers show higher achievement based on grade point average (Mean GPA = 3.418). The low standard deviation of the Tesla/NAC completers ($\sigma = 0.526$) indicated a tighter cluster around the mean GPA indicating that there are a large number of high academic achievers as opposed to a wide dispersion of both high and low academic achievers. Additionally, the larger percentage of students earning a cumulative 4.0 GPA among the Tesla/NAC completers (7.14%) compared to their Appleton East counterparts (1.84%) indicated a higher caliber group of students. Current literature on the academic achievement of students in STEM-focused schools indicates that these students are more likely to engage in rigorous math and science coursework and perform at a higher level than their traditional school counterparts (Wiswall, Stiefel, Schwartz, & Boccardo, 2014). In addition to higher performance in math and science, a study of ten STEM schools from around the nation found higher scores in English as well (Scott, 2012).

Research Question 2 sought to identify what relationship Tesla/NAC completion had on post-secondary completion rates. Tesla/NAC completers had a much higher tendency to pursue programs of study at four-year colleges and universities (88.10%) compared to students in the other three groups (East=45.05%, Tesla participants=53.13%, NAC participants=58.33%) and, when combined with other post-secondary plans including two-year vocational schools and the military, Tesla/NAC completers increased to 100% in their pursuit of post-secondary training and education. By way of comparison, of the nearly 59,000 high school students in Wisconsin who graduated in 2016, 52.51% planned to enroll in a four-year college or university, 21.15%

planned to enroll in a two-year vocational college, and 3.04% planned to join the military (Wisconsin Department of Public Instruction, 2018e). While intention does not directly reflect post-secondary completion, it may indicate that the students have taken steps to explore their career options and plan for their post-secondary pathway.

It is also interesting to note the number of students in the Tesla participant and robotics participant categories who elected to pursue a two-year vocational degree. The number of students in these two categories choosing a two-year degree were substantially higher than in the Tesla/NAC completer category. However, this indicates that the vast majority of the students understand the value of a post-secondary education.

By way of comparison, of the students in Wisconsin who completed high school in 2015, 14.8% intended to enroll in a two-year college and 38.3% intended to enroll in a four-year college following graduation (Wisconsin Department of Public Instruction, 2018d). When we explore statistics specific to students from STEM-based secondary schools, the data is difficult to find. However, gathering data on career interest is part of the ACT exam that many high school students take. 48% of high school graduates who took the ACT and participated in the related ACT career interest survey over the last six years expressed an interest in STEM careers (ACT, 2017).

Research Question 3 sought to understand how academic achievement compared between students who complete both Tesla and the NAC and those who participated in only one or the other, or neither. Tesla/NAC completers had a higher mean GPA than all other groups and a relatively smaller standard deviation. This could be for a variety of reasons including increased academic ability coming into the school, increased parental involvement, the comprehensive nature of classroom academics tied with after-school practical experiences, or the general

socioeconomic status of the group. Because of the small sample size of three of the four groups studied, conclusions are drawn based on a small amount of data. A larger sample size and data set involving a larger span of years would allow for inferential statistics to be employed to determine specific relationships among different data points.

Out of all four groups, those who participated in Tesla but did not graduate from Tesla had the lowest mean GPA and the second highest standard deviation. This could indicate that students within this group come from a wide range of academic abilities and interests.

Conclusions

The difference in the size of the subject groups (East n=1414, Tesla/NAC completer n=42) could call into question the validity of the study. However, regardless of the sample size for Tesla/NAC completers, the data still provided insights into the demographic makeup, academic achievement, and post-secondary intentions of the group. These insights created additional questions that can be answered in future studies.

Based on the data gathered for this study, the findings indicate a difference in the groups studied relating to academic performance and post-secondary ambitions. The caliber of student attracted to Tesla and the robotics team may play a part in the difference in achievement. Appleton Area School District (AASD) graduation requirements for traditional students involves 23 credits of coursework, both required and elective. Tesla/NAC completers regularly earn more than 30 credits by graduation. Tesla/NAC completers also have a higher tendency to engage in Advanced Placement (AP) coursework throughout their high school career. The heavy credit load, the rigor of both the STEM and AP coursework, and the high average GPA being attained, suggest these are talented, motivated students.

One surprising data point was the difference in percentage of students who are eligible for the FRL program. While 43.21% of the Appleton East graduates qualify for the FRL program, only 14.29% of Tesla/NAC completers are eligible. The recruitment strategy for both Tesla and the robotics team is to inform all students and parents of the opportunity to participate and does not target any one specific population. However, there may be a preconceived notion among students, parents, guidance counselors, and teachers that Tesla is a rigorous school catering to those students who are highly talented in math and science. While there is truth to the rigorous academic content within Tesla, it is not intended for top-tier students, but rather for all students who have an interest in STEM. The same holds true for the robotics team. The FRL difference between the Tesla/NAC completers group and the Appleton East High School group is large enough to warrant further exploration.

When looking at the data for the Tesla and NAC participants, there is a high percentage choosing a two-year vocational path. Based on the data, it is evident these students understand the value of post-secondary education. A qualitative study would provide more concrete data regarding why students are choosing this path and help to clarify whether these students are choosing a two-year degree path as a stepping stone to a four-year engineering degree or pursing the two-year degree to move directly into a technical career.

Recommendations

This study begins to highlight the impact that focused learning and concurrent participation in a related after-school activity has on student performance and post-secondary intentions. While it is a small piece of the larger picture, it is the first step in determining the impact on students in these environments to excel academically and make sound post-secondary decisions. The results of this study and the recommendations outlined below will be presented to

the Tesla Charter Board for their review. This study will also be provided to the Appleton Area School District and available to other districts considering a program similar to Tesla and the NEW Apple Corps.

First, it is recommended that the AASD implement systems and procedures that provide ready electronic access to student academic data including ACT scores and post-secondary completion. The lack of availability of this data limited the data analysis in this study and conclusions that could be drawn. The district as a whole could benefit from easy access to this data to inform future decisions for improvement.

Second, the AASD is encouraged to explore more deeply the impact of small learning communities on student academic and post-secondary achievement. Both the literature and results from the study suggest benefits of smaller learning communities. In a district with high schools that have enrollments in the 1,500-student range, being part of a smaller learning community of like-minded students with similar interests provides an opportunity for students to be part of a close-knit cohort of learners. These students rely on one another to be successful together and as individuals. The support system that is provided within the context of both Tesla and the robotics team has the potential to impact student academic achievement and post-secondary planning.

Third, GPA differences among the groups would suggest the Tesla/NAC completers are high-achieving students but it does not indicate why these high achievers choose the rigors involved in committing to completion of Tesla and the NAC. A qualitative study should seek to determine why students choose to enroll in Tesla and participate on the robotics team and why, despite the rigor and intensity, they choose to make the necessary sacrifices to complete the program. Deeper exploration of socio-economic factors, student involvement beyond the

classroom and the robotics team (i.e. Scouts, Explorers, Youth Apprenticeships, CTSOs, etc.), and other influencers on students should also be considered.

Finally, given the demographic makeup of Tesla and robotics team students, it is recommended that stakeholders of Tesla and the robotics team examine their recruitment practices, both in general and as it relates to disadvantaged or underrepresented populations. Tesla and the robotics team should attract students who have an interest in STEM, robotics, and/or advanced technical skills, regardless of background, socioeconomic status, gender, or race. A review of the recruitment materials and practices may shed light on the lack of diversity within Tesla and the robotics team.

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