Introduction: Project SYNCERE is a Chicago-based non-profit whose mission is to prepare the minds and create pathways for underrepresented and disadvantaged students to pursue careers in the Science, Technology, Engineering, and Math (STEM) fields. First launched in 2009, our programs ensure youth from underserved communities have access to opportunities that will inspire and prepare them for future careers in STEM.

Project SYNCERE is the dream of three African American men, who at an early age, learned the power of education and technology. Dissatisfied with the lack of diversity in their fields of engineering and financial management, they left corporate America to start an organization devoted to encouraging students to embrace the STEM fields. Project SYNCERE now provides opportunities to thousands of students in Chicago Public Schools (CPS) who have been traditionally underrepresented in STEM.

Chicago Public Schools is the 3rd largest school district in the nation and is comprised of 644 total schools serving 361,314 students. The school district is large and diverse, yet 76.6% of the students are classified as economically disadvantaged and 83.3% (36.6% African American and 46.7% Hispanic) are underrepresented minorities.

Project SYNCERE proposes to expand, refine, and evaluate its in-school project-based learning engineering curriculum, ENpowered. The ENpowered Program is implemented over the course of 10-weeks to high-needs students in schools on the west and south side of Chicago. Presently, ENpowered is being implemented in 15 schools across the district and serving 300 students.

Absolute Priorities: Project SYNCERE recognizes the need to bring additional project-based learning enrichment activities to high-needs students to promote STEM learning. Under the ENpowered Program, Project SYNCERE will develop and implement four middle school project-based learning curriculum units that incorporate principles of engineering design thinking and various engineering disciplines to improve knowledge of and interest in STEM education and careers for high-needs students. The proposed plan addresses Absolute Priorities 1 and 3.

Significance: There's no question that engineering and other STEM careers are at the center of our country's success. In recent years, the United States job market has seen growth in many engineering sectors, but the number of engineers available to fill this need has remained stagnant.

Engineers stand at the forefront of developing the nation's innovation as well as sustaining our ongoing development. There are plenty of engineering jobs available, yet there is a decreasing number of US-based engineers willing or even ready to fill them. Based on research compiled by Burning-Glass there are 2.5 entry-level job postings for each new 4-year graduate in STEM fields compared to 1.1 postings for each new Bachelor of Arts graduate in non-STEM fields. In addition, STEM careers offer a substantial salary premium of 26% for jobs requiring a bachelor's degree and a 28% premium for jobs at the sub-Bachelor's degree level.

According to the Bureau of Labor, 75% of all of the fastest growing occupations across the globe are based in science and math, particularly some form of engineering. STEM-related jobs grew at three times the rate of non-STEM jobs between 2000 and 2010 and it was projected that by 2018, 2.4 million STEM jobs would go unfilled.

The United States must do better at attracting and retaining students in the STEM fields, especially in the areas of women and underrepresented minority groups. According to the National Math and Science Initiative, the average US workforce is 48 percent women, but in STEM careers women make up only 24 percent. Attracting more women into the engineering fields will prove crucial in increasing the number of graduates who are ready and apply to fill the need.?? The National Action Council for Minorities in Engineering's President and CEO, Dr. Irving McPhail, in 2011 highlighted statistics indicating that less than 12.5% of engineering bachelor degrees were awarded to underrepresented minorities, which represent 30% of the nation's population. As a component of its strategic plan, The National Science Foundation has publicly recognized that the challenges to the national competitiveness and sustained STEM global leadership can be better met through the full utilization of all of the nation's talent and resources. Increasing educational initiatives for minorities and improving the state of our high school STEM teachers are 2 key steps in improving engineer production. Two-thirds of all teachers across the US who teach science, math, or physics didn't major in their respective field. This unfortunate lack of qualified STEM teachers means that many students aren't learning everything that STEM has to offer. They are, in essence, failing to see STEM as a viable career path either due to misunderstanding or disinterest.

Since only approximately 10% of elementary students regularly engage in hands-on science, students often reach middle school underprepared and unmotivated to pursue pathways that could lead to a career in STEM, contributing to an opportunity gap in STEM (Carroll 2014; Weinstein, Whitesell, and Leardo 2014). This is a major reason why formal education alone struggles to positively impact student learning and close gaps in achievement; other authors describe this phenomenon as underachievement relative to potential (Flores 2007; Ford and Moore 2013). To disrupt existing patterns of performance outcomes in STEM, students must be engaged in authentic ways. Persistence in STEM depends not only on academic preparedness in school but also informal learning experiences, family and peer support, and individual student characteristics (Dorsen, Carlson, and Goodyear 2006; Olszewski-Kubilius 2006). For communities underrepresented in STEM fields—students of color, girls and women, and students from low-income families—research demonstrates the importance of engagement both in and out of school in a STEM ecosystem that includes teachers, afterschool programs, and the community (Krishnamurthi et al. 2013). Participation in informal STEM learning has a stronger impact on underserved girls and women, minorities, and lower-income communities' career paths because it both supplements and complements formal education that has a history of weeding those groups out (Weinstein, Whitesell, and Leardo 2014).

Students from underrepresented communities face the additional hurdle of limited STEM-specific career guidance, as it can be extremely challenging for students to envision themselves in a career that in many cases is unfamiliar to them or to their family (Cohen and Patterson 2012; Dorsen, Carlson, and Goodyear 2006). Student interactions with STEM mentor professionals help to illuminate pathways to STEM careers, which has proven especially important for first-generation students (Adams, Gupta, and DeFelice 2012; DeWitt and Archer 2015). In research undertaken at the college level, Campbell and Campbell's 1997 study quantifies the significant positive effects of mentoring on students' GPA (2.45 vs. 2.29), course load (9.33 units per semester vs. 8.49), and lowered dropout rates (14.5% vs. 26.3%). When mentors and students connect in this way, it is an example of Ito et al.'s *connected learning* (2013): "Connected learning is realized when a young person is able to pursue a personal interest or passion with the support of friends and caring adults, and is in turn able to link this learning and interest to academic achievement, career success or civic engagement." The connected learning model is based on a combination of individual interest and social supports ?? to help students overcome adversity and successfully pursue learning pathways.

<u>An Exceptional, Innovative Approach that Builds on Existing Strategies:</u> The ENpowered Program highlights a new and exceptional approach to solving our STEM crisis through a combination of research-based strategies. In brief, the ENpowered Program is exceptional and innovative in a few ways. 1) it provides students with engineering project-based lessons that are connected to a real-world project to make learning relevant for the students 2) it pairs students with STEM professionals to help illuminate pathways to the STEM workforce 3) lessons are taught by engineers who have been provided the necessary pedagogy to increase content knowledge 4) competition is used as an engagement tool to increase students "buy-in" to the material being taught and 5) it bridges an informal style of learning into the school day.

Rationale: The ENpowered Program is based on research and principles from the utilization of a project-based learning (PBL) curriculum, mentor engagement, instructor pedagogy, and competition however it takes it a step further by combining them in an informal learning context. Each component described below is shown in the attached logic model, along with implementation activities, outcomes and measures.

ENpowered Components - Each of the curriculum components is detailed below, however none of the components function independently. They are intertwined in the 10-week program that students receive through a rigorous development and implementation process.

A Project-based Learning Approach - The ENpowered Program is based on a PBL framework that is utilized to drive connections of the engineering challenges students work on to real-world issues. It also helps to connect their learning to other subjects involved in the project such as math and science. In a project-based approach to learning, students are first presented with a real-world problem or issue and then learn the content necessary to answer questions they have derived in response to the problem. During the process of questioning, research, ideation, and developing solutions, students build the problem solving, project management, collaboration, and leadership skills necessary for success in the world beyond the classroom. In addition, PBL supports students learning by: 1) bridging thinking across disciplines, 2) promoting deeper connections to content and 3) fostering the inquiry skills necessary for success in STEM.

Engineering projects are a great way to utilize PBL principles in the classroom to connect student learning across subjects. An ideal example would be an engineering project that asks students to design solutions for real-world problems. Consider that in the mathematics classroom, problem solving has long been promoted as the way for teachers and students to climb up the

Bloom's taxonomy pyramid. Engineering projects steer students past simple questions of how many apples Sally has and toward authentic problem-solving situations. Whereas students in science class can sometimes get bogged down in following a series of steps to verify an accepted scientific fact, engineering projects open their eyes to the discipline's true nature. Projects that ask students to apply current knowledge and exploration to new areas in pursuit of the elusive "best" solution make them active players in the world of science. Finally, when students see technology through the lens of engineering, they understand that it's much more than a synonym for "something that can be plugged in." Engineering both drives innovation of technology and uses technology to create advancements in the world around us.

Mentor Engagement - Ensuring that students have the opportunity to interact with STEM professionals is a key component of the program. Prior research has established the importance of support from family (Witkow & Fuligini, in press) and from faculty (Cole, 2007) in predicting future success of students. Syed, Azmitia, and Cooper (in press) suggest that family, friends, and faculty can act as identity agents for students by offering social support and facilitating individuals' identity development and academic success. These identity agents become critical forces for underrepresented minority students, who often face isolation and stereotyping in the academic environment (Syed et al., in press). We hypothesize that these same principles are even more important for students in the middle school grades, where students are still trying to find their identity. For the ENpowered Program, mentors visit with students at least twice throughout the 10-week program to introduce students to their careers in engineering and to serve as teaching assistants as the students continue to work on their projects. The mentors and their respective companies also volunteer with Project SYNCERE at the concluding ENpowered Games competition to cheer on their respective partnering school and serve as an inspiration while the students work on their design challenges.

Instructor Pedagogy – Utilizing engineers and engineering students as instructors - As engineering and other STEM disciplines continues to grow in popularity, the question that always comes up is who is going to teach it. In a recent survey by Start-Engineering of K-12 engineering education experts on why and how to teach engineering, nearly 80% of experts identified teacher training as the biggest obstacle to engineering becoming widely and successfully integrated into K-12 education. Teacher resistance was the 2nd largest obstacle at 58%. The result is that, many teachers who are responsible for teaching STEM subjects such as math and science don't have the training to do so well. Roughly 30% of chemistry and physics teachers in public high schools did not major in these fields and haven't earned a certificate to teach those subjects, according to a survey by the National Center for Education Statistics (NCES). Half of earth science teachers are similarly unqualified. Many of these teachers simply don't have the content knowledge to properly inspire and engage students in their learning.

Project SYNCERE recognizes these inadequacies in our educational system and will employ reverse tactics to engage students in their learning. Our team of instructors consist of engineering professionals and engineering students who are taught the pedagogy necessary to become effective teachers instead of the content knowledge and principles of engineering. When paired with the classroom instructor to lead the program, our collective team of instructors and teachers are able to effectively engage students in engineering lesson and scaffold their learning over the course of the 10-week program.

Competition - At the conclusion of the program, students will participate in the ENpowered Games Competition, which provides an opportunity for them to showcase the engineering skills and knowledge they gained. During the competition, students work in teams of 4 to solve a series of engineering challenges based on the principles they studied weeks prior. Research has shown that competition when structured correctly can have comprehensive benefits to student learning outcomes. Competition has shown positive impacts on improving teamwork and collaboration, enhancing social and emotional learning, strengthening academic self-concept, facilitating growth mindsets, building mental toughness and improving risk analysis. In traditional school there is little opportunity to teach these skills, but more and more educators are beginning to understand the importance of these 21st century skills. Through competition, we aim to increase student's excitement about engineering and help students see that there are other students who look like them and come from similar communities that are also interested in these fields.

Informal Learning - The ENpowered Program utilizes an informal learning approach to teach students valuable STEM skills during the school day. We adopted this approach because we needed to disrupt the traditional way students learn about STEM subject matters. In many of the environments we teach, students often don't feel connected to the work or inspired to learn about the subjects being taught. Studies show that informal learning environments increase students' interest in STEM (e.g., Mohr-Schroeder et al. School Sci Math 114: 291–301, 2014) and increase the chances a student will pursue a STEM career (Kitchen et al. Sci Educ 102: 529–547, 2018). Students' attitudes and perceptions toward STEM are affected by their motivation, experience, and self-efficacy (Brown et al. J STEM Educ Innov Res 17: 27, 2016). The academic and social experiences students' have are also important. Traditionally, formal learning is taught in a solitary form (Martin Science Education 88: S71–S82, 2004), while, informal learning is brimming with chances to connect and intermingle with peers (Denson et al. J STEM Educ: Innovations and Research 16: 11, 2015).

By using an authentic STEM workspace, we are able to foster a learning environment that extends and deepens STEM content learning while providing opportunities and access to content, settings and materials most students wouldn't otherwise have access to. The access to authentic STEM activities, paired with access to STEM professionals and knowledgeable instructors make the experiences provided in the ENpowered Program invaluable to the development of our future STEM workforce.

Quality of the Project Design: - Through our work, Project SYNCERE (PS) strives to ensure all students have the resources and access to opportunities that will inspire and prepare them for future careers in STEM. In this project, Project SYNCERE proposes to expand, refine and evaluate its ENpowered Program, which features components chosen with the primary goal to integrate field-initiated innovations – promoting Science, Technology, Engineering and Math (STEM) education, with a particular focus on Computer Science in an effort to support 6th grade students, particularly those classified as high-needs.

The ENpowered Program is an informal STEM program that combines the key components of a PBL engineering-based curriculum, mentor engagement, engineering professionals and students as instructors, and the benefits of a competition. We hypothesize that the combination of these components will be provide the stimulus and motivation necessary to increase students interest in STEM careers and put them on a pathway for furthering their pursuit of excellence in the STEM fields.

ENpowered is based on a 10-week informal in-school program at target schools on the south and west sides of Chicago. Project SYNCERE's administration team identifies target schools that are interested in increasing the level of STEM rigor available to their students and who are fully supportive of our efforts. For the proposed project, we will expand the program from 15 to 22 schools in 2019. The grant will fund the implementation of the program in seven schools during the 1st four years of the grant. At each of the schools, we will implement the ENpowered Program in one 6th grade classroom serving 20-25 students per classroom for a total of 150 students/year. The program will take place during the science class at each participating school to add supplemental enrichment to students' learning. All sites will be staffed by two Project SYNCERE instructors, who will join the science teacher, twice weekly for 1-class period to implement the engineering focused curriculum. The designed curriculum will be aligned with both Next Generation Science Standards (NGSS) as well as Common Core Standards for Math.

ENpowered's curriculum is designed using a PBL framework. The engineering principles and practices that students learn are framed around real-world issues to ensure connections to the work. During the 10-week period, students go through a series of lessons and mini-projects to build their understanding of specific engineering principles, while reinforcing many of the math and science principles they are also learning in school. Each week the principles build on those from the previous week (scaffolding their learning), while allowing time for STE reflection and student lead discussions. Through the utilization of the PBL framework, connections are made for student across subject areas and they develop an understanding of how to properly utilize the engineering design process (EDP), which is the cornerstone of the curriculum.

To solve problems, engineers follow a series of steps called the "engineering design process". In our curriculum, we teach students a 5-step version of the EDP, which includes: Ask, Imagine, Plan, Create and Improve. The Ask process defines the process and identifies the constraints. The Imagine process is where the brainstorming of solutions occurs. The Plan process includes students making a sketch of their proposed solution and listing their needed materials. The Create process, allows students to follow their plans and create prototypes of their solution. The Improve process allows students to figure out what worked and what didn't work to decide what they can do to improve their design. The great thing about the EDP process is that it is flexible and that it's a continuous cycle. You can begin at any step, focus on just one step, move back and forth between steps, or repeat the cycle.

During the grant period, we will create four new curriculum units in partnership with an industry partner. They will be engineering focused, utilize a PBL framework, scaffold students learning and focus on the principles of engineering design. The platform for all of the projects will be VEX Robotics, but the challenges incorporating this platform will change yearly. Vex Robotics is a leading manufacturer of robotics kits for middle school and high school students around the world. Although very mechanical by nature, we will utilize the kits to cover a wide range of concepts that allow the students to build their skills and knowledge in a various engineering disciplines, while also seeing the diversity of it. One curriculum unit will be utilized across all program sites each year. Some of the concepts/challenges that may be covered in the curriculum units include: Crane Design (civil/electrical/mechanical engineering), Drag Race/Tractor Pull Competition (mechanical/electrical engineering), Prosthetic Hand Design (biomedical/mechanical/electrical) and Mechanical Bridge Design (civil/electrical/mechanical engineering).

As with most well developed PBL lessons, these engineering projects will reinforce and develop many math and science principles that are at and above grade level for students such as number theory and systems, algebraic thinking, geometry and spatial reasoning, measurement, energy and engineering design.

To add to the authenticity of the curriculum and to connect the work back to STEM career paths, we pair each school with a local engineering company (supporting letters can be found in the appendix). Each company is responsible for recruiting mentors to visit with its respective partner school at least twice during the 10-week period (typically during the 3rd and 8th week of the program) and also again at the ENpowered Games Competition. During the school visits, mentors introduce themselves to the students, share information about their current profession and talk with students about the importance of the work they are doing. Through the partnership, mentors are able to provide guidance and serve as role models for the students. The proverb stands true: students cannot be what they cannot see. For a student searching for a personal identity in the world and expanding their consciousness, mentorship provides an answer to the most pressing academic and professional career decisions they are undertaking every day.

The mentorship section of the project is very powerful as it provides many benefits to the curriculum/classroom such as: empowerment of students, students are able to ask thoughtful questions and get immediate feedback, students learn valuable information about future career options, students gain the confidence to dream about solving problems, and it provides inspiration to help students digest difficult concepts more clearly.

The instructional team that is responsible for implementing the program are all Project SYNCERE staff members. We recruit, train and develop engineering professionals as well as current college students in their junior year and greater to work as our Engineering Program Facilitators (EPFs). We value the knowledge that these individuals have as engineers and provide them with the pedagogy necessary to effectively implement the curriculum in a school-based setting. Once hired, EPF's go through a rigorous professional development process to teach them how to be effective teachers specifically in an urban environment.

At the conclusion of the 10-week program, we bring all of the students together to compete in the ENpowered Games Competition. This 1-day event serves as the culmination to the program and allows students the opportunity to showcase their talent in front of parents, community leaders, industry partners, school officials and one other. For the competition, we create two new challenges that utilize all of the engineering and technical skills that students have learned over the prior 10-weeks. The goal is to 1) test students ability to work in teams to solve problems 2) gain an understanding of how well students are able to apply the concepts that were taught 3) inspire students become champions of their own efforts 4) celebrate the successes of all of the students and 5) show students that there are many of students who look like them and come from similar communities that are also interested in STEM.

Table 1. ENpowered Goals, Objectives and Outcomes

Goals	**Objectives**	**Outcomes**
1. Develop four 10-week curriculum units that incorporate engineering design principles, while utilizing a PBL framework	Project SYNCERE will design a different curriculum unit for each year of the grant that addresses a different engineering focus. This will happen in collaboration with at least one industry partner. The curriculum will: ● be connected to a real-world issue ● address NGSS standards and Common Core standards for math ● teach student how to effectively utilize the engineering design process to solve problems	Four stand-alone curriculums will be developed that connect students' learning to real-world issues as well as strengthen students' knowledge of math and science principles. The curriculums provide the foundation for the challenges students face during the ENpowered Games Competition.
2. Train and support Project SYNCERE instructors to implement the curriculum with fidelity	Project SYNCERE will train and support its engineering instructors to successfully implement the curriculum covering: ● Pedagogical content knowledge ● Curriculum implementation ● Technical expertise ● Teaching strategies supporting student learning	At least 8 Project SYNCERE instructors will have received PD on the curriculum units and will have an increased capacity to effectively teach the materials to middle school students. Instructors will have an increased understanding of how to relay STEM concepts to students, while having them work in teams to lead their own discovery of the engineering principles and concepts being presented.
3. Implement the designed curriculum with fidelity over a 10-week period in collaboration with 7 school partners	Instructors will implement the curriculum to the intended population. Students will learn the following: ● Grade level math and science content ● How to effectively utilize the Engineering Design Process as a problem-solving approach ● Engineering skills and principles ● Exposure to new career fields	Instructors will implement the curriculum to 150 students per year, with at least 90% of them being high-need students. Students will have an increased exposure to STEM and understanding of engineering principles.

4. Recruit corporate partners for each school	Our team will identify and recruit corporate partners to pair with each of our partnering schools. Each corporate partner will provide the following services to the program: ● At least 3 mentors will visit and work with each school a minimum of two times during the course of the in-school program. ● At least 3 volunteers to support the implementation of the ENpowered Games Competition ● Funding to support the program at the conclusion of the grant cycle	Each school will have at least 3 mentors that engage with them during the implementation of the program. The mentors will provide the students with early STEM career exposure, increased confidence in their ability to succeed in these fields, increased relevance to and understanding of the principles being taught.
5. Implement the ENpowered Games Competition at the conclusion of the 10-week period	The ENpowered Games provides an opportunity for students to come together to showcase their skills and knowledge gained through the program. The competition will: ● Challenge students to work in teams to solve a series of engineering challenges ● Allow them to test their skills in engineering design thinking and other core engineering disciplines	A 1-day competition will be implemented at the conclusion of the program to further engage students in their learning. The competition will impact students' teamwork and collaboration skills, improve their social and emotional learning, facilitate growth mindsets and build their mental toughness.
6. Improve students' academic outcomes	1. Improve student learning of mathematics content 2. Improve student learning of science content	After one year of program participation, ENpowered participants will achieve math and science scores that are at least 10% (of a standard deviation) higher compared to the comparison group.
7. Improve student's STEM attitudinal outcomes	Improve student attitudes related to STEM fields and careers. 1. Increased STEM engagement 2. Increased self-efficacy 3. Increased STEM career awareness	Increase the proportion of students who agree or strongly agree to evaluation questions regarding attitudinal outcomes related to STEM by 25%

Performance Feedback and Continuous Improvement - Several mechanisms for feedback and continuous improvement are built into our program (See Table 2). These mechanisms consist of bi-weekly program meetings, weekly instructor site check-ins, bi-monthly classroom observations and bi-weekly management meetings. In addition, PRG will provide feedback to the PS team based on the data it is collecting and report on its progress on the evaluation. As the program initiates, we will also generate a more detailed schedule and timeline with deliverables that is managed in TaskRay, which is part of our Salesforce CRM platform.

Dissemination - Project SYNCERE and PRG will collaborate on applications to present at relevant conferences such as IES, International Society for Technology in Education, Society for Research on Educational Effectiveness, and American Evaluation Association. Dr. Jenner will take the lead on writing journal articles in close collaboration with Project SYNCERE. Potential journals may include: *American Journal of Education, Educational Researcher, Science Education,* and *Journal of Education for Students Placed at Risk.* Project SYNCERE will provide evaluation results to participating schools and corporate partners. Project SYNCERE will also disseminate research results through our organizational communication platforms including sharing results on social media; featuring results on our website; and sending highlights to Project SYNCERE's email list.

Management Plan: We have carefully budgeted the program by task, ensuring that it can be accomplished on budget. Project SYNCERE has a history of strong fiscal management and academic performance and has been recognized by many of its corporate partners and the school district for its exceptional work in the community. Project SYNCERE also has a history of managing large projects and grant dollars as it has a current annual budget of $1,392,000. The tasks have been scheduled to guide the progress through the work, ensuring the program is completed on schedule.

Table 2. ENpowered Schedule

Timeline	Activity	Responsibility

Ongoing	• Bi-weekly admin program team meetings – all activity reported and feedback for improvement provided • Weekly instructor site check-ins to obtain feedback and ideas for improvement • Bi-weekly management meetings • Bi-monthly classroom observations to ensure program fidelity and to provide feedback for continuous improvement • Bi-weekly PS/PRG meetings to discuss evaluation progress • **Milestone** – Monthly reports on project progress with emphasis on critical periods such as curriculum progress, mentor progress and competition progress	Coleman, Wheeler, Brown, Constantian and all EPFs, PRG
Years 1 – 4		
Aug. – Oct.	• Project SYNCERE recruits school partners • Project SYNCERE recruits corporate partners • Project SYNCERE leads development of curriculum units with the assistance of industry partner • PRG enters into data sharing agreement with CPS (Y1); PRG submits data request to CPS (Y2-Y5)	Coleman, Wheeler, Johnson, Brown, Constantian, Industry Partner and relevant staff, PRG
Nov. – Dec.	• **Milestone -** School partners are solidified and agreements are in place • **Milestone -** Corporate partners are solidified and paired with school partner • **Milestone -** Mentors are identified from corporate partners and provided training on student engagement • **Milestone -** Development of curriculum unit is finalized • Instructors are provided professional development on implementation strategies for curriculum units • Materials and equipment are procured for the upcoming program implementation • Program team meets with science teachers and school administration to discuss implementation plan, strategies and intended outcomes • Project SYNCERE and industry partner develop engineering challenges for the ENpowered Games Competition	Coleman, Wheeler, Johnson, Brown, Constantian, Industry Partner, and relevant staff
Jan. – Apr.	• Instructors implement curriculum units at partner schools • PRG team begins to implement their evaluation strategies • Corporate mentors engage with students at their respective partner school • **Milestone –** Engineering challenges for the ENpowered Games are finalized • Planning of the ENpowered Games Competition is finalized in collaboration with The Gemini Group	Coleman, Wheeler, Wilson, Johnson, Brown, Constantian, PRG, The Gemini Group, Industry Partners, and relevant staff
May	• **Milestone –** Implementation of ENpowered Games Competition	PS Staff PRG, The Gemini Group, and Industry Partners
Year 5		

Ongoing	● Data analysis ● PRG and Project SYNCERE will disseminate results through presentations, workshops at national conference, and publications submitted to peer-reviewed journals ● PRG submits final evaluation report to USED ● **Milestone –** Final report complete; Findings disseminated	Coleman, Wheeler, PRG and relevant staff

Personnel - The Project SYNCERE core team has more than 10 years of experience designing and implementing effective STEM programs in Chicago. Currently, Project SYNCERE is the largest provider of engineering focused programs to K-12 students in the Chicago area, serving more than 3,000 students annually. Their roles are well established, and they work efficiently together to produce remarkable results. Personnel background and responsibilities follow.

Jason Coleman, the Executive Director and Co-Founder of Project SYNCERE will oversee and manage the grant. Coleman will help co-manage the development of the curriculum and challenges for the ENpowered Games Competition. A veteran engineer and STEM leader, he has raised over $6 million dollars over the last 10 years to implement the activities of Project SYNCERE. Coleman has been instrumental in the design and implementation of programs and strategies that have changed the trajectory for thousands of high needs youth throughout Chicago.

Adrianne Wheeler, the Program Director, will manage the implementation of the project and oversee its deliverables. Wheeler will also oversee the development of curriculum units and the challenges for the ENpowered Games Competition. Wheeler also an engineer by training has over 9 years of STEM programming experience and more than 5 years of design, evaluation and oversight of STEM programs. Over the past 5 years she has led the implementation of over 200 programs to engage more than 12,000 youth. She is currently pursuing her Ed.D in Educational Leadership at DePaul to further her insight in the field.

Ovetta Brown, Program Manager, will manage half of the program sites during the implementation of the project. She will oversee the management and recruitment of those schools as well as provide the necessary professional development activities to the staff on curriculum implementation and pedagogy. Brown also a STEM degree holder has more than 6 years of experience leading and managing STEM programs.

Emily Constantian, Program Manager, will manage the other half of the program sites during the implementation of the project. She will oversee the management and recruitment of those schools and provide necessary professional development activities to staff on curriculum implementation and pedagogy. Constantian has 3+ years of Program Management experience.

Evin Marie Johnson, Director of Marketing and Development, will oversee the recruitment and management of the industry partners and mentors. She brings more than 14 years of experience in the nonprofit space leading and managing projects that build capacity of the organization.

Valencia Turner, Operations Coordinator, will manage the recruitment and scheduling of the Engineering Program Facilitators. She will also be responsible for asset management during the Project. She brings more than 17 years of Operations experience in both the corporate and nonprofit space.

George Wilson, Director of Operations and Co-Founder of Project SYNCERE, will manage the expenditures for the program budget. As a former grants manager for Northwestern University, he brings more than 16 years of accounting, budgetary and operations experience to the project. He is also responsible for approving timesheets and payroll for the organization.

Eric Jenner, Ph.D, Lead Evaluator, PRG, will serve as Principal Investigator (PI). Dr. Jenner has served as the PI for two completed i3 Development grants and serves as the PI for two current i3 Development/EIR Early Phase grants, and several other ongoing RCTs, quasi- experimental, and observational studies. Dr. Jenner serves as a peer reviewer for the *Journal of Education for Students Placed At Risk* and received his What Works Clearinghouse Certification for group design standards from the Institute of Education Sciences (IES) in June 2014.

Potential for continued support after the project - After the project has concluded and the Federal funding is no longer available, we will continue these efforts through the support of our corporate and other philanthropic partners. A large component of the project is getting buy-in and support from industry partners who see the viability of the work we are doing. Many of these companies already provide financial support to our organization and the additional ones that we secure during this grant period will have the potential to become future funders of the work. With the evidence that we are able to produce through this grant, we will be able to prove to the larger audience of corporate funders, the need to fund this project, while also providing a vehicle for them to get involved in the project through volunteer engagement in addition to their financial contributions. (letters of support from several industry partners is attached)

Quality of Project Evaluation: Project SYNCERE has engaged The Policy & Research Group (PRG) as the independent evaluator (see MOU in *Appendix C*). The logic model (*Appendix G*) hypothesizes how ENpowered, a project-based learning engineering curriculum, will improve 6th grade students' achievement in mathematics, science, as well as their self-reported non-cognitive STEM outcomes. The evaluation will test these hypotheses using: 1) a quasi-experimental, comparison group design to draw causal inferences about the effects (impact) of ENpowered and 2) an implementation evaluation to understand how ENpowered works in practice, interpret its efficacy, provide feedback for program improvement, and identify features necessary for sustainability and replication. The impact evaluation investigates whether offering ENpowered to students impacts their educational outcomes. The proposed impact evaluation will produce evidence that will meet What Works Clearinghouse evidence standards *with reservations.*

Research questions. We are proposing to answer one ***primary research question***: as compared to students who are similar but not exposed to the program (comparison), what is the impact of participating in ENpowered (treatment) on math achievement at the end of the academic school year (as measured by 6th grade Partnership for Assessment of Readiness for College and Careers [PARCC] standardized test scores)? This research question reflects Project Goal 6 as specified in Table 1 in Appendix G-2 In addition, we propose to investigate the following ***exploratory (secondary) research questions*** which will examine how identified mediators influence the hypothesized outcomes: **1)** What are the long-term impacts (two years post-program) on a select group of participants' science achievement (as measured by standardized 8th grade science scores, Obj. 6.2)? **2)** What are the intermediate impacts on math achievement for a select group of ENpowered participants that participated in the program for one year vs. those who participated for two years (as measured by 7th grade standardized test scores, Obj. 6.1)? What are the short-term (immediate post-program) impacts of the offer to receive ENpowered (treatment) on participants' reported: **3)** STEM engagement (Obj. 7.1), **4)** self-efficacy in STEM (Obj. 7.2), and **5)** STEM career awareness (Obj. 7.3). And, finally: **6)** To what extent do components of fidelity of implementation (i.e., adherence, quality, comparison group experience, and context) impact the effect of ENpowered on students' outcomes? The exploratory research will go beyond the impact findings to determine not just whether the program is effective at improving the identified primary outcome, but if the program works, whom it works for and under what circumstances it is most/least effective. These questions should have value for future program development and to provide guidance and inform future replication efforts. The impact study design and methods will meet **WWC evidence standards *with reservations*.**

Sample identification/selection, sample size, and minimal detectable effect size. Students will be selected into the treatment sample if they are 6th graders enrolled in 15 selected public middle schools in the Chicago Public School District (CPS) and are receiving the ENpowered intervention. The comparison group will consist of a similar number of students in the 6th grade who are attending equivalent schools in the same district (share background and achievement characteristics); propensity score matching or weighting will then be used to maximize the equivalence of these two groups on observed and theoretically relevant baseline characteristics. Currently, approximately 300 6th graders are receiving ENpowered annually. An additional 150 6th grade students will receive ENpowered each year in grant years one through four, for a total treatment sample of 600 students. Based on several standard assumptions and reasonable expectations this study should yield a Minimal Detectable Effect Size (MDES) of at most .15 (Hedges' g) after four years of data collection.[i] The analytic sample (600 students experiencing ENpowered and 600 matched comparison students) will be adequately powered to detect an effect of this size. In fact, this estimate represents the highest possible MDES, with the most conservative assumptions applied.

Prior to conducting propensity score matching or weighting to optimize the balance of comparison and treatment students, PRG will pre-screen the pool of students for initial eligibility. Empirical research finds that pre-screening is essential to reduce unobserved selection effects.[ii],[iii],[iv] These pools of students will be 6th grade students the same year as treatment students (i.e. no time confound) attending schools that are: 1) similar to a treatment schools in relevant and observed characteristics (e.g. race/ethnicity, gender, free and reduced lunch status, 5th grade test scores) and 2) in the same district (a district-run CPS K-8 school). Given that there are over 400 district-run K-8 schools in CPS and over 27,000 enrolled 6th graders, we anticipate that there will be sufficient pools of similar comparison students. Once these pools have been selected and baseline data have been gathered from all participating (treatment and comparison) pools, but before outcome data are examined, PRG will implement individual-level matching or weighting procedures. Specific procedures will be finalized in the research design prior to receiving outcome data, but PRG will likely use propensity score weighting or matching to select an observational comparison group that is equal in expectation to the treatment group (i.e. renders treatment assignment ignorable, conditional on propensity score).[v] Alternative strategies include Mahalanobis distance matching, which is preferable when there are fewer baseline covariates and reason to prioritize one or more variables in the prediction of the distance score. The evaluators will produce descriptive statistics of all relevant baseline variables of interest after matching to verify covariate balance. We will validate this with baseline equivalence diagnostic tests (using standardized mean differences) on observed baseline variables that are highly predictive of the outcome variables (i.e. 5th grade pre-intervention standardized math scores) as is specified by What Works Clearinghouse review standards. As per WWC standards, and the evidence review protocol for middle-school mathematics, baseline equivalence of the treatment and comparison samples will be established for the analytic sample on the basis of the pre-test measure of the outcome (at minimum).

Outcome measures and data collection. To measure the impact of the intervention, PRG will collect primary outcome data from student-level standardized math test scores from Chicago Public School District (CPS). Educational outcome data will be requested by PRG from the school district in the summer following each year of implementation; data-sharing agreements with CPS will be formalized. We summarize data sources, collection methods, timelines, and analytic approaches by research question in *Appendix I.*

PRG will collect exploratory outcome data from two sources: 1) an *Outcome Questionnaire* to collect self-reported measures of non-cognitive outcomes from study participants for the exploratory research questions (treatment only), and 2) student-level standardized science test score data (5th and 8th grade). Please see *Appendix I* for examples of items to include in the *Outcome Questionnaire*. All items and scales used for outcome measurement will be composed of measures that have been used and validated in published research. The same questionnaire will be administered by PRG at baseline (within one month of the beginning of the school year) and 9 months later for students enrolled in ENpowered in grant years two through four (approximately 450 total). Additionally, PRG will collect 8th grade science test score data from CPS for study participants (treatment and comparison) who complete the 8th grade by the end of grant year four (approximately 600 total).

Analytic approach. Contrasts in academic outcomes will be analyzed at the individual-level, employing a difference-in-differences (DID) approach. For each student, we will use a single pre- and single post-intervention observation, and measure the impacts of the intervention as the average "difference in differences" between the treatment and comparison groups. We will estimate the academic achievement DID impact with a multi-level model that includes covariates plus random and fixed effects for classrooms and schools. Covariates will be grand-mean centered for analysis. With few identifying assumptions, the DID model produces a point estimate of impact that represents the mean difference in pre-to-post intervention change for both groups. The estimate of impact is the coefficient value for the interaction term in the estimating model. The evaluators will infer impact if that term is significant and meaningful in magnitude. PRG will conduct **baseline equivalence** testing on demographic and outcome data gathered at baseline, including pre-intervention PARCC mathematics test scores. Because the design involves matching at the individual (student) level, **joiners** are not a concern as they would be in a cluster random assignment design (group assignment, such as at the classroom or school level) as per the Revised Cluster Design Standards.[vi] Exploratory sub-group analyses will be analyzed similarly. We will employ a DID modeling strategy to estimate the impact on the sub sample of students who complete two years of programming and with those who complete a science test. Different comparison samples will be generated, though matching/weighting procedures will be identical. Non-cognitive outcomes will be analyzed as treatment-only pre/post test design, whereby we will estimate the mean difference in pre and post test scores (controlling for observed characteristics) and test for statistical significance using a longitudinal multi-level empirical modeling strategy. The estimates for these latter exploratory outcomes are of formative value to the program developers and will not have a causal interpretation.

Methods for implementation study. PRG will design and conduct an implementation evaluation to understand variation in how ENpowered works in practice, interpret the efficacy of the intervention, provide feedback for program improvement, and identify features and conditions necessary for sustainability and replication. The implementation evaluation will assess and report on: adherence, quality, comparison group experiences, and contextual factors. Implementation data will be reported to Project SYNCERE semi-annually as formative feedback. Fidelity measures will include program dosage and online fidelity surveys for Project SYNCERE staff following each session. Annual thresholds are set for each key component depicted in the logic model as specified in *Appendix G* and will be assessed and reported on annually. Please see the *Implementation Evaluation Summary Table* in *Appx. I.* Quantitative data, such as dosage data and close-ended questions from the survey, will be analyzed descriptively. To analyze qualitative data gathered in interviews and open-ended survey questions, the evaluators will use a grounded theory approach. This approach allows the evaluators to conduct flexible yet focused qualitative analysis through a systematic coding process to identify emergent themes and meaningful patterns of ideas in the data.[vii], [viii]

Independent evaluator qualifications. PRG has led over 50 federally-funded evaluations, including 14 quasi-experimental studies. Dr. Eric Jenner, PI, received his *What Works Clearinghouse Certification* for group design standards in 2014 from the Department of Education Institute of Education Sciences. He has over 10 years' experience supervising rigorous evaluations and serves as a peer reviewer for the *Journal of Education for Students Placed at Risk*. He will be assisted by Katie Lass, MSW, MPH, and Kelly Burgess, MPH.

[i] Effect size estimates are calculated with *Optimal Design* and reflect the following expectations: power () = .80, significance () =.05 and a two-tailed significance test, with a random effects model to account for the nested/clustered structure of the data (rho=.20). Estimates also include the expectation that covariates (including the pretest) should explain at least 20% of the variation of the outcome, which is conservative.

[ii] Song, M. and Herman, R. (2010). Critical Issues and Common Pitfalls in Designing and Conducting Impact Studies in Education: Lessons Learned from the What Works Clearinghouse (Phase I). Educational Evaluation and Policy Analysis, 32, 351-371.

[iii] Glazerman, S., D., M. Levy, and D. Myers. (2003). "Nonexperimental Versus Experimental Estimates of Earnings Impacts." Annals of the American Academy of Political and Social Science 589 (1): 63-93.

[iv] Cook, T. D., Shadish, W. R., and Wong, V. C. (2008). Three conditions under which experiment, and observational studies produce comparable causal estimates: New findings from within-study comparisons. Journal of Policy Analysis and Management, 27(4), 724–750.

[v] Mahalanobis or Euclidean distance matching are other alternatives that may be used.

[vi] http://ies.ed.gov/ncee/wwc/documentsum.aspx?sid=259

[vii] Charmaz, K. (2006). *Constructing Grounded Theory: A Practical Guide through Analysis*. California: SAGE Publications, Inc.

[viii] Guest, G., MacQueen, K., & Namey, E. (2012). *Applied Thematic Analysis*. California: SAGE Publications, Inc.

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