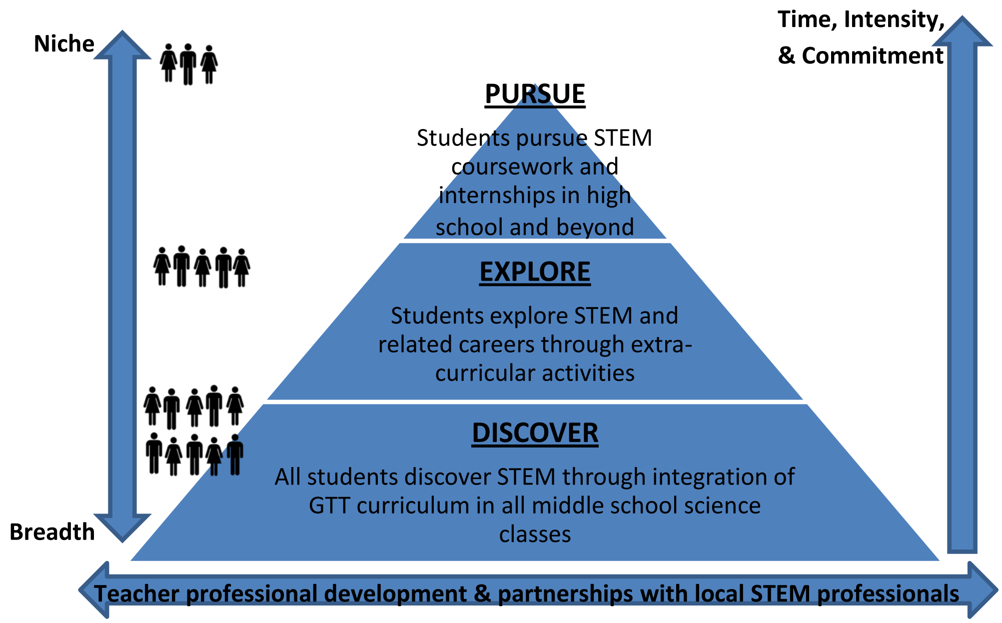
A. QUALITY OF PROJECT DESIGN

Clark County School District (CCSD) seeks funding to develop and evaluate the Pathways to STEM Initiative (PSI), a unique fusion of promising and complementary strategies for involving students in STEM and preparing them to complete STEM coursework. It addresses **Absolute Priority 2** and **Competitive Preferences 8 and 10** by: (1) providing middle and high school students access to rigorous and engaging project-based STEM coursework that uses cutting-edge technology and equipment, (2) creating extra-curricular opportunities for students to explore STEM concepts and real-world applications alongside STEM professionals, and (3) preparing educators to deliver the coursework, with emphasis on the needs of students with learning disabilities and English language learners in a project-based environment. The PSI model allows students to discover, explore and pursue STEM by providing various levels of involvement. This can be conceptualized with a STEM delivery pyramid (Figure 1).

Figure 1. STEM Delivery Pyramid



Discover STEM (Level 1) – At the base of the pyramid, we address the fundamental need for increasing student performance and interest in STEM learning by integrating Project Lead The Way's (PLTW) Gateway To Technology (GTT) curriculum into middle school science classes. PLTW was selected because it is a leading provider of project-based STEM curricula that has shown promise for engaging and preparing students of diverse backgrounds (see Appendix D). PLTW's approach relies on hands-on, real-world projects that help students understand how the information and skills they learn in the classroom may be applied to everyday life. This method can increase student engagement and achievement, especially among high needs students. Furthermore, GTT units uphold the core ideas of *A Framework for K-12 Science Education* that link science with technology and engineering. PLTW GTT units will provide frameworks to support the Nature of Science Unifying Concepts found within the Nevada State Science Content Standards in grades 6–8 and to pique student interest in STEM topics.

GTT's Design and Modeling (DM) unit will be implemented at the sixth grade level to guide students to use an engineering notebook to document ideas and introduce the design process for problem-solving. Students will use 3D modeling software to design and create virtual images and collaboratively construct solutions to identified concerns. Teachers will incorporate the DM unit as outlined in the Life Science benchmark calendar for PLTW, Science 6 GTT. Seventh grade students will continue with the DM unit and also study units of Energy and the Environment (EE) and Green Architecture (GA). In the EE unit, students investigate the Earth's environment through internal and external energy sources to understand a variety of Earth and atmospheric processes. They design and model alternative energy sources and evaluate ways to reduce energy consumption through efficiency and sustainability. The GA unit introduces architectural plans, construction styles, sustainability, and materials for 3D design projects. Correlations between units will support the Earth Science benchmark calendar for PLTW, Science 7 GTT. Eighth grade students will participate in units of Automation and Robotics (AR), Flight and Space (FS), and the Magic of Electrons (ME). AR will allow students to learn mechanical systems and energy transfer through a robotics platform. They will use this platform to develop a solution to an existing problem. The FS unit will introduce and reinforce standards as students explore the science behind aeronautics and use their knowledge to design and build an airfoil. Finally, the ME unit uses hands-on projects to explore electricity, the properties of matter and parts of atoms so students can understand circuitry design. Students will study real world topics in association with units to support the Physical Science benchmark calendar for PLTW, Science 8 GTT.

This project will provide all middle grades students with rigorous and engaging coursework that will prepare them academically and introduce the possibility of STEM careers. While not every youth will want to pursue STEM, we will solidify science concepts for all students while igniting STEM interest for many whom otherwise would not have considered such a path.

Explore STEM (Level 2) – Once introduced to STEM through GTT, students who wish to explore further may become involved in extra-curricular activities (the middle layer in Figure 1) that will deepen learning, bridge concepts from the classroom to actual applications, and convey pre-requisites for pursuing STEM careers. Because STEM projects lend themselves to solving real problems, service learning will be incorporated into this component of PSI. This will demonstrate to students how they can develop solutions to address relevant community issues. Out of school time activities will include:

1) Weekly sessions with STEM professionals – Students and teachers will work with STEM professionals to explore everyday functions of concepts learned during the GTT units of study. These collaborations will run quarterly and serve up to 40 students/school/quarter (640 students/year). Groups will meet after school once/week at each middle school site. Each quarter will culminate with a field trip relevant to the issue explored during the sessions. If there is greater interest than capacity, participants will be chosen randomly with efforts to ensure students can participate in at least one quarterly rotation. The following example illustrates how this would be carried out: In their science class, 8th grade students will investigate the structure of an atom and the motion of electrons through the Magic of Electrons GTT unit. During concurrent after school sessions with professionals, STEM partners will guide student participants through projects of circuitry design and fabrication, emphasizing real-world applications. The quarterly rotation then ends with student tours of physics and electricity laboratories provided by the College of Sciences at the University of Nevada, Las Vegas. Appendix C provides a list of professionals who have committed time and resources to this endeavor.

2) STEM Club – Since the weekly sessions serve 40 students/school/quarter, a STEM club will meet once/week after school during the year. This will sustain ongoing interest in extra-curricular projects. Students not currently participating in quarterly rotations may attend the club, with each meeting accommodating up to 30 students. Whereas a STEM professional will facilitate the quarterly rotations, a STEM club advisor will work with teachers to lead the club. Students will complete hands-on projects that extend classroom learning in an informal setting. Continuing with the example provided above, the Magic of Electrons GTT unit delivered in class would be augmented with electromotive hands-on projects during STEM club time.

3) Summer Camp – Students will be invited to a 10-day summer camp held on the campuses of the four middle schools. They will complete complex projects and interact with STEM professionals and PSI high school students who will share their educational experiences and career pathways. Students will participate in project exhibitions and competitions that promote collaborative teams to solve problems. Publicly showcasing projects will also promote family and community involvement and make STEM concepts more relevant and accessible to all. Summer camp will be open to the first 150 students/school (600 students/year). If there is greater interest than capacity, participants will be chosen randomly with priority given to those who were involved in the after school components.

Pursue STEM (Level 3) – By the time these students transition to high school, we expect that they will be prepared to succeed in their science courses. We also expect that many of them will want to pursue STEM careers and post-secondary study. To meet the needs and interests of these students (the peak of the pyramid in Figure 1), we will offer:

1) High school level PLTW courses – Students at target high schools may enroll in credit-bearing PLTW elective courses within one of two programs: Pathway to Engineering (PTE) and Biomedical Sciences (BMS). Both PTE and BMS use project-based learning strategies which focus on creativity, teamwork, and problem solving; both are designed to prepare students for postsecondary education and STEM related careers. These courses also support Nevada requirements for high school proficiency exams in mathematics and science by motivating students to move from Depth of Knowledge (DOK) level 1, recall, to DOK level 3, strategic thinking. The high school proficiency exams measure students on a broad spectrum of science and mathematics content at a DOK level 3 with skills in reasoning, planning, complexity, and abstract thinking. The PLTW coursework is designed for strategic thinking as students explore, present alternative applications to solve problems, and take action to validate and justify technical decisions. Additionally, these courses complement traditional mathematics and science courses to strengthen student understanding and knowledge of course content.

2) STEM industry mentors, opportunities for job-shadowing, and internships – In years two and three of the project, high school students will complete on-site job shadowing and internship experiences. Ninth and tenth graders will shadow STEM professionals at work sites for eight hours twice/semester, while 11th and 12th graders will fulfill internships 4 hours per week over a five week period. This will immerse students in the world of work to gain first-hand information about skills and careers, creating a critical link between STEM education and career pathways. Students will also be paired with a mentor from the STEM industry. Professionals will be encouraged to engage students in service learning experiences that emphasize the utility of STEM for addressing real-world problems. Appendix C lists professionals who have committed to working with students in these capacities.

Unlike traditional methods relying only on science standards and curricular programs, this project will deliver continuous support through strong partnerships with community professionals committed to developing STEM education. Experiences with occupations will help students understand that science and engineering are not isolated from society.

Adult Preparation (The substratum) – While the three levels of the delivery pyramid described above relate to cultivating student interest in STEM and then sustaining it through increasingly intense and focused activities over time, the pyramid also depicts teacher professional development and partnerships with local professionals as the bedrock of this initiative. Ultimately, the success of this model hinges on the ability of teachers and mentors to provide project-based learning opportunities in an engaging, motivating and relevant way. As such, teachers will receive professional development and ongoing support to prepare them to deliver a technology-rich, project-based curriculum in a manner that is accessible and exciting for all students including those with disabilities and limited English proficiency. Teachers and

STEM professional volunteers will also receive training on positive youth development (PYD) so they can cultivate supportive relationships with students. Science teachers, special education co-teachers, and CCSD ELL Specialists will complete three phases of PLTW training to acquire skills needed to implement this project. Phase 1 prepares teachers for PLTW Core Training Institutes. Phase 2 is a two-week Core Training Institute for each PLTW course they will teach. These provide an in-depth and hands-on course-specific training of the curriculum with a focus on pedagogy and professional networking. Phase 3 is ongoing professional development largely administered through a Virtual Academy which provides detailed materials lessons in every PLTW course, videos of PLTW Master Teachers teaching lessons, and collaboration tools.

Since participating teachers will be new to PLTW curricula, CCSD educators who have experience implementing PLTW will provide them with additional support and preparation during Phase 1. They will learn how PLTW relates to Nevada science standards as well as Next Generation Science Standards, and they will become familiar with software and other technology necessary for delivering PLTW units. Following the PLTW institutes, CCSD ELL Specialists will also provide science teachers and special education co-teachers with professional development focused on language strategies for project-based learning and will follow up with coaching and modeling. If there is teacher turnover, new staff will also receive the preparation and support described above. Furthermore, a STEM Professional Learning Community at each campus, inclusive of teachers from other disciplines, will provide a collaborative environment and opportunities for integrating STEM into other subject areas. As special education students rotate between classes with co-teach instructors, additional associations between teachers will occur as natural extensions of lesson planning and student assessment.

In order to sustain student interest and to target groups traditionally underrepresented in STEM, this project will serve four middle schools and two high schools that are feeder-aligned and have high percentages of minorities, students with disabilities, students with limited English proficiency, and students from low socioeconomic status. Table 1 provides demographics at the selected schools, demonstrating that Hispanic/Latino or Black/African American groups are overrepresented at these sites compared to District percentages. The same is true for students with disabilities (IEP); students with limited English proficiency (LEP); and students who qualify for free and reduced lunch (FRL), a measure of poverty.

Table 1. CCSD PSI Sites: Demographics (2010-2011 Count Day Data)

	Total Enrollment	% Hispanic, Latino	% Black, African American	% White	% Other	% IEP	% LEP	% FRL
District	**309,749**	**42.1**	**12.4**	**31.9**	**13.6**	**10.2**	**23.0**	**50.8**
Garside MS	1,150	68.0	9.0	14.5	8.5	12.3	36.4	72.4
Gibson MS	1,035	72.3	10.6	9.7	7.4	6.6	35.6	78.6
Findlay MS	1,527	38.6	28.7	18.4	14.3	12.2	15.4	61.1
Johnston MS	1,422	38.0	29.7	17.3	15	13.9	14.9	63.7
Mojave HS	2,067	45.3	31.4	17.4	5.9	13.9	13.8	54.9
Western HS	2,294	64.7	17.0	11.3	7.0	15.9	24.8	66.0

These demographics directly target traditionally underrepresented groups in STEM for participation; however, out of school time activities will be marketed carefully so that all students are invited to participate with emphasis on reaching out to students from underrepresented groups. For example, multilingual informational materials will be distributed through science classes and special education teachers and ELL specialists will directly contact families to ensure they receive and understand the invitations. Further outreach will occur through open house nights and parent advisory meetings. If participation from underrepresented groups is insufficient, the project facilitator will investigate and address barriers to participation.

In sum, PSI will provide students with an uninterrupted pathway to discover, explore, and pursue STEM in order to increase the number and diversity of students prepared for postsecondary study and careers in STEM. There are three project goals. ***Goal 1*: *Increase student interest and preparation for post-secondary options and career development in STEM fields through project-based learning experiences.*** *Strategies:* Implement PLTW curricula; afterschool programs and summer camps involving STEM professionals and teachers; job shadowing, internships, and mentoring. *Outcome Objectives:* Increased student achievement in science; increased commitment toward school and learning; increased interest and participation in STEM; knowledge of preparation needed for STEM careers; positive and consistent relationships with peers, teachers and STEM professionals. ***Goal 2*: *Encourage and support students from groups traditionally underrepresented in STEM to participate in project-based learning experiences.*** *Strategies*: Select schools with large proportions of groups traditionally underrepresented in STEM; target these groups for participation through outreach, promotional materials, and relationships with STEM professionals. *Outcome Objective*: Increased interest, participation and success in STEM among students from diverse groups. ***Goal 3*: *Provide teachers with high quality professional development and supports that prepare them to deliver rigorous and engaging project-based STEM curricula.*** *Strategies:* PLTW training for science teachers, special education co-teachers and ELL specialists; ELL specialists provide professional development, mentoring and coaching for ELL strategies; relationships with STEM industry professionals. *Outcome Objectives*: Increased teacher knowledge and efficacy for implementing

PLTW curricula and extra-curricular STEM activities; develop a repository of STEM lessons and best practices; develop enduring, reciprocal relations between teachers and STEM professionals.

The Tables in Appendix J illustrate the cost of this project per student per year and estimates of scaling up to 100,000; 250,000; and 500,000 students. Table A summarizes CCSD's proposed project budget serving up to 5,600 students in Year 1, and 5,780 students in Years 2 and 3. It also shows the start-up and operating costs in each year, including indirect costs. The costs per student are: $209 in Year 1, $150 in Year 2, and $162 in Year 3. The start-up and operating costs illustrate that per student costs for start-up are generally less than operating costs. Costs decrease from Years 1 to 2; however, there is an increase of $12 per student in Year 3 due to an increased cost for the external evaluator. Tables B – D show the costs required to scale up the project, revealing similar patterns as Table A in terms of start-up versus operating costs. Costs decrease in Year 2 but increase in Year 3 due to final program evaluation activities. Overall, per student costs decline with the increase to 100,000 students, but stay static as the number of students increase to 250,000 and 500,000, respectively. As every LEA will have its own needs, there will be variables that affect the per student costs including: staffing, technology, hourly teacher pay for trainings outside of the work day, the amount of before- and after-school tutoring needed for students, and the cost for the external evaluator selected at the discretion of the LEA. Given these potential variables, the cost analysis does suggest that costs to LEAs will decrease over time as resources are invested in the program and as the number of targeted students increase.

Table E in Appendix J shows further analysis of the reasonableness of program costs, demonstrating that the cost per student for PLTW lands in the middle range when compared to other STEM curricula. The cost of PLTW, therefore, is reasonable when considering the quality and quantity of teacher trainings, classroom consumables, provision of assessments for project-based learning, and the number of students to be served. The total cost of CCSD's after-school and summer programs are $30,840 per year. This cost includes salaries for Club Advisors and teachers as well as supplies needed for project-based learning activities. It is projected that up to 910 students per year may be served in the after-school and summer programs, which equates to $34/student. National statistics on after-school programs indicate that typical per student costs for after-school programs such as 21st Century Community Learning Centers can range from $673 to $1,215 per student and the average number of students who regularly attend these programs is 82 (Afterschool Alliance, 2008). Given these comparisons, CCSD's program cost is reasonable and will impact a higher number of students.

If the evaluation of PSI demonstrates that it successfully achieves the intended outcomes, CCSD will incorporate these activities into its ongoing efforts to grow future STEM professionals. PSI is designed for sustainability. Year one implementation costs include PLTW professional development and technology. Thereafter, expenditures decrease as the majority of personnel complete training and become self-sufficient enough to rely on colleagues through virtual tools and PLCs. Professional development associated with teacher turnover will be supported through collaboration with the University of Nevada, Las Vegas as a PLTW satellite campus. As the number of personnel proficient in PLTW grows, they will assist with PSI orientation, Phase I training, and PLC leadership. Further expansion of PSI will occur through stronger community partnerships. As more CCSD students graduate with interest and preparation for STEM careers, it will be easier to garner additional partner commitments to support PSI. Positive results confirmed through evaluation and outcomes will enable CCSD and its partners to scale PSI and share this model with other districts.

B. SIGNIFICANCE

The PSI model proposes an **exceptional approach** to increasing student performance and interest in STEM by integrating strategies that have traditionally been implemented separately: 1) providing rigorous STEM coursework that uses project-based learning and ensures students with unique learning needs receive support; 2) fostering extra-curricular STEM involvement; 3) engaging industry mentors to help students and teachers understand the relevance of STEM; and 4) preparing and supporting teachers through professional development and networking. Unlike other models that target students who meet academic criteria or who demonstrate predispositions toward STEM, this model exposes all students to rigorous, hands-on curriculum during the school day and provides out of school time opportunities for deeper involvement. The intersection of these strategies and the delivery method will improve student achievement in science while kindling interest in STEM and creating pathways that support student interest.

We rely on research supporting the effectiveness of carefully designed and well implemented project-based learning (PBL) and on research supporting out of school time programs to hypothesize that PSI will improve student achievement in science and increase interest and preparation for STEM careers for all students, including those from underrepresented groups. Appendix D presents some recent research suggesting that PBL can improve science content knowledge and process skills. In fact Hmelo-Silver, Duncan & Chinn (2007) argue that instead of asking “Does it work?” we should be asking “under what circumstances do guided inquiry approaches work?” A growing body of evidence suggests that teacher professional development and sustained support are essential elements of a successful PBL program (Geier et al., 2008; Blumenfeld et al., 1991; Soloway et al., 1996). Geier et al. (2008) finds that PBL can increase science achievement on standardized tests when a guided inquiry curriculum is highly specified, developed, and aligned with teacher professional development and administrative support. Moreover, the effects are cumulative. Students with higher levels of participation exhibit higher achievement. Their analyses found moderate effect sizes of 0.44 and 0.37 for two cohorts. Similarly, Lynch et al. (2007) find small to moderate effect sizes (0.17 - 0.41) depending on the demographic subgroup. While the intervention in this study did not close science achievement gaps, it did not widen them as was observed with the comparison group. In fact, the subgroups with the greatest effect sizes were groups that traditionally underperform in science: Hispanic (d=0.34) and students who were previously English language learners (d=0.41). Results also indicate that the intervention eliminated achievement differences between current and former FRL students; and it was equally effective for students with disabilities as for students without disabilities, for males and females and for White and African American students. Nonetheless, the authors conclude that while hands-on science and direct experiences may be a necessary component of science instruction, they are not sufficient. Science concepts require “time to learn, well-sequenced instruction with adequate scaffolding, and engaging experiences in science labs.”

Complementing the evidence on project-based learning during school time, there is also research indicating informal STEM education during out of school time may be a successful strategy for increasing the number of students engaging and succeeding in STEM. Goss, Wimer and Little (2008) synthesize findings from research and evaluation studies that rely on experimental or quasi-experimental designs to determine effects of after school programs (ASP), and they find that well-implemented programs have positive impacts on academic, developmental and prevention outcomes, especially among disadvantaged youth. They identify three crucial factors for achieving positive outcomes: (1) access to and sustained participation in the program; (2) quality programming and staffing; and (3) promoting strong partnerships among entities that influence student learning. Durlak & Weissberg (2007) also reviewed 73 ASP evaluations that included control groups and found empirical support for the ability of well-run ASPs to improve youths' self-perceptions, bonding to school, behavior, and academic achievement. They conclude that effective programs employed skill-development activities that were sequential, based on active learning, focused and explicit. They estimate the average effect size on achievement tests for programs that exhibit these traits at 0.31, compared to 0.03 for programs that do not. Evaluation findings from various STEM ASPs are also find positive impacts on student engagement, persistence through postsecondary school, and pursuit of STEM fields among underrepresented youth (The Afterschool Alliance 2010 & 2011; McClure & Rodriquez, 2007). STEM learning is well suited for ASPs because out-school-time is structured yet flexible enough to allow for project-based learning that requires extended blocks of time for hands-on, youth-directed exploration. Research also suggests that self-efficacy in STEM is equally important as content knowledge, especially for female and minority youth (McClure & Rodriguez, 2007; Sorge, Horton & Hagerty, 2011). ASPs can impact students' self-confidence in STEM fields when they provide an environment that encourages inquiry without fear of academic failure (Afterschool Alliance, 2011; Dahlgren and Noam, 2008; NIOST, 2007). Also key to successful STEM programs that target underrepresented groups is exposure to role models/mentors and the development of positive relationships within a community of practice.

The strategies proposed by PSI embody the key characteristics of successful PBL and out of school time programs identified in the literature. It relies on a well-developed curriculum; provides extensive support for teachers; sustains student participation through a pathway approach; creates strong partnerships; skill development activities are sequential, based on active learning, focused and explicit; and teachers and STEM professionals serve as role models/mentors for students. PSI will advance the field by developing a practical STEM delivery model that targets all students at the entry point, thereby supporting general improved student achievement in science while attracting as many students as possible to pursue STEM. Evaluating the effectiveness of this model will advance current theory, knowledge and practice concerning the structures and supports necessary for a STEM education framework that is rigorous, accessible to all students, and stimulates and sustains progressively deeper involvement in STEM. It will especially contribute knowledge concerning students with unique learning needs in a PBL environment. Findings from PSI will expand this area of research and document implementation so that a refined model can be shared and replicated in CCSD and other settings.

C. QUALITY OF MANAGEMENT PLAN AND PERSONNEL

The District selected personnel with relevant research, educational and project management experience to lead and implement PSI. Project staff will also collaborate with partnering organizations and with underrepresented groups that have a common interest in improving student achievement while promoting STEM related activities. Management of PSI will reside within the Curriculum and Professional Development Division (CPDD) of the Clark County School District (CCSD). Assistant Superintendent **Karen Stanley s**upervises CPDD where she manages over 120 staff and a $415 million annual budget. Ms. Stanley is responsible for the planning and development of curriculum; improvement of programs within her zone; and special projects for K-12 mathematics, science, English language arts, social studies, career and technical education, physical education, and the fine arts. She also oversees guidance and counseling programs and student athletics and activities. PSI's project director, **Mary Pike**, is the Director of Science, Health, Physical Education, Foreign Language, and Driver Education in the CPDD. Mrs. Pike oversees curriculum development and revision, textbook adoption, professional development for teachers and administrators, science safety, grant writing and implementation, foreign exchange student placement, proficiency tutoring programs, and charter school curriculum audits. She has been the project director for many grants, such as the Carol M. White Physical Education Program Grant, two Math-Science Partnerships Grants, the Youth Risk Behavior Surveillance Grant, and the JASON Project Grant. In addition, she has provided oversight for several grant awards to include: the Southern Nevada Health District Grant; the Communities Putting Prevention to Work Grant; the Prevention First Grant; Title II Science and Health Grant; and CCSD general fund budgets. Mrs. Pike is on the Board of Trustees for Gathering Genius, which is Nevada's State STEM Coalition, and on the Board of Trustees for the National Atomic Testing Museum. She is devoted to public education and strives to collaborate with stakeholders to ensure that all students are college and career ready upon graduation. A PSI **Project Facilitator** will be hired to act as liaison between the schools and the Curriculum and Professional Development Division. The Project Facilitator will plan, develop, and provide professional development and curricular support to schools served under this grant. The facilitator will also provide leadership, content knowledge, and expertise in STEM related curriculum to promote the Pathways to STEM Initiative. This person will work collaboratively with members of local, regional, and state organizations; businesses; and institutions of higher education to promote sustainable relationships within school communities. In addition, the project facilitator will work with teachers and administrators to support consistency among professional development opportunities focusing on project goals and objectives/outcomes. The Project Facilitator will report to the Project Director, Mrs. Mary Pike.

Opal Ingram, an experienced grant coordinator, will provide fiscal oversight for PSI. Ms. Ingram has developed and secured millions of dollars in grant funding for the District. She has also overseen expenditures for federal, state, and foundation funded projects. She will approve all grant expenditures based upon District and federal guidelines for this grant. Ms. Ingram will be the liaison between the District and the U. S. Department of Education. **Judet Diaz,** researcher and program evaluator with the District, has developed and executed evaluation plans for grant-funded projects at the federal, state, and local level. She has experience with program evaluation, quantitative and qualitative research methods, and data collection and analysis. She will collaborate with the external evaluator and provide necessary data to support a rigorous program evaluation. If awarded and approved by the CCSD Board of Trustees, the Evaluation Research Program at WestEd will conduct the evaluation. WestEd is well established in the area of educational research and program evaluation. Juan Carlos Bojorquez and Jerome Hipps will lead PSI's evaluation. Bojorquez has conducted rigorous evaluations for WestEd for the past 11 years, including evaluations of the Beckman@Science Initiative and the National Endowment for the Arts Summer Schools in the Arts program. Jerome Hipps brings experience with evaluations of after-school and community programs, including Chicago Public Schools' Community Schools Initiative, building a professional development module for the federal 21st Century Community Learning Centers Program, and WestEd's state evaluation of California's high school after-school program. The project team will include **Jonathan Nakamoto**, who will conduct the quantitative analyses; **Kadijah Salaam**, who will coordinate data collection and analysis efforts; and **Emanda Thomas**, who will support data collection and analysis. **John F. Flaherty** and **Sharon Herpin** will serve as internal project advisors.

The Project Timeline below outlines management activities, milestones and individuals responsible for implementation steps.

Project Timeline

Date	Milestones/Activity	Responsible Party
Jan 2013	Receive Grant Award Notification (GAN) & communicate to all stakeholders	PD and GC
Jan 2013	Budget set up, training on spending procedures and required documentation	PD and GC
Jan 2013	Finalize contract and data collection timeline with external evaluator; begin evaluation activities	PD, DPE, and EE
Jan 2013	Hire project facilitator & identify Club Advisors at each school	PD and PF
Jan 2013 & annually	Purchase needed project supplies for each year	PD and PF
Jan - July 2013	Schedule and conduct training with the school staff and school partners	PD
March, June, Sept., Dec 2013 & annually	Quarterly meetings with staff and evaluator to review project status	PD, PF, EE, and DPE
Aug 2013 & annually	External evaluator submits interim evaluation report	PD, PF, DPE and EE
Aug 2013 – June 2014 & annually	Implement PLTW curricula in middle schools, after school sessions with STEM professionals and STEM club activities	PD and PF
Dec 2013 & annually	Submit Performance Report	PD, PF, DPE, EE, GC, and FADA

June – July 2014 & 2015	Conduct summer camp	PD, PF and OP
Aug 2014 – June 2015 & annually	Implement STEM electives in high schools	PD and PF
Aug 2014 – June 2015 & annually	Conduct job shadowing and after school activities	PF and OP
Mar 2016	Submit Final Performance Report	PD, PF, DPE, EE, GC, and FADA

Project Director – PD; Project Facilitator = PF; District Program Evaluator = DPE; External Evaluator = EE; Grant Coordinator = GC; Other Partners = OP; Fiscal Accountability & Data Analysis = FADA

D. QUALITY OF PROJECT EVALUATION

The proposed evaluation employs a matched comparison group design and includes both formative and summative components. The formative component, based largely in the implementation evaluation, will begin in year one and continue through the performance period. The summative component will be based in the outcome evaluation and examine impact of the first two years of implementation. Additionally, we will conduct a case study on a sample of students from the first cohort. Evaluators will use a multi-method approach, collecting and analyzing quantitative and qualitative data from multiple perspectives and respondents.

Evaluation Design: WestEd proposes a quasi-experimental design with a matched comparison group of non-PSI schools to examine the overall impact of PSI on students' science achievement. Using the same quasi-experimental design, we will examine program impact on outcomes measured by a student survey: commitment to school and learning; knowledge of STEM and STEM careers; interest in STEM and STEM careers; relationships with peers, teachers, and STEM professionals; and participation in STEM courses and activities. Well-designed quasi-experimental studies with matched comparison groups using students' prior achievement as statistical controls can allow evaluators to draw strong inferences about program impact when random assignment is not feasible (Shadish, Cook, & Campbell, 2002). WestEd will select comparison schools from within CCSD's 52 middle schools to control bias (Cook, Shadish, & Wong, 2008). Schools will be matched on size, achievement scores, racial/ethnic composition, English language learner composition, and economic status. WestEd intends to use Mahalanobis distance matching, a multivariate matching algorithm, to select comparison schools. WestEd proposes a one-to-many matching strategy in order to improve the statistical power of the analyses. Given the resources needed to administer surveys to large numbers of students, we will select two non-PSI schools for each PSI school and administer student surveys in these 12 schools. For the analyses with grade 8 Science criterion referenced tests (CRTs), we will select two additional comparison schools for each PSI school so that analyses will include a total of four PSI schools and 16 non-PSI schools. **Measures:** The evaluation will use several measures to assess outcomes. Student achievement data will come from the grade 8 Science CRT administered as part of the Nevada Proficiency Examination Program. This test is only administered in the eighth grade. As a result, this data will be supplemented by an evaluator developed STEM knowledge item inventory aligned with Nevada's curriculum standards that will be incorporated into surveys that students complete at other grade levels. The Attitude Toward Science in School Assessment (Germann, 1988) will also be administered to students to measure their interest and engagement in STEM. Guided by the program's logic model (Appendix J) the evaluation team will also develop a series of surveys/interviews for teachers, administrators, and students that support the implementation and outcome evaluations, measure key outcomes, and provide data about key program elements. **Outcome Analysis**: The outcome (summative) evaluation will examine program impact on both achievement (i.e., science CRT, STEM knowledge) and behavior/attitude outcomes (i.e., student STEM-related attitudes, interests, behaviors, etc.). Analysis of teacher outcomes will focus on teacher STEM-related knowledge, teacher preparedness and efficacy implementing curricula. The following questions guide the outcome evaluation: (1) What is the overall impact of PSI on student and teacher outcomes? (2) Does increased participation in PSI activities yield more positive student/teacher outcomes? (3) Do some subpopulations of students benefit more from PSI than others?

WestEd will utilize 3-level hierarchical linear models (HLM; Raudenbush & Bryk, 2002) to analyze CRT and student survey data in order to account for student clustering within classes and schools. HLM is needed to accurately estimate program impact on student achievement. After years 1 and 2 of PSI implementation, WestEd will conduct HLM analyses to examine the overall impact of PSI on student achievement on the grade 8 Science CRT. An exploratory set of HLM analyses will also examine whether PSI has an impact on 8^{th} grade Math and Reading scores. WestEd will also use HLM analyses to assess the overall impact of PSI on the student outcomes measured by surveys. 6^{th}-8^{th} grade students will complete the surveys in year 1; 6^{th}-9^{th} grade students will complete the surveys in year 2.

The HLM analyses will include the students' prior CRT scores, student-level demographic variables, and, if available, teacher- and school-level control variables (e.g., years of teaching experience and previous school achievement). A dichotomous variable entered after the control variables will provide the test of the program effect on the outcome variables and interaction terms will allow additional analyses that examine whether the PSI program has a differential impact on certain subpopulations (e.g., English language learners). An important limitation of the proposed HLM analyses is the small number of schools that will be included in the models. Given the research demonstrating that estimation problems are more likely to occur when the number of higher-level units is below 30 (Maas & Hox, 2005), we may encounter difficulties with the proposed analyses. However, the benefits of more accurate significance tests that result from using HLM outweigh the potential problems.

Descriptive Analysis of High School Data: WestEd will conduct descriptive analyses with data from PSI students after they have enrolled in the two high schools that are linked to the four PSI middle schools focusing, on science course enrollment, average grades in these classes, and average performance on the common district curriculum assessments provided in these classes. Although these analyses will not allow for a direct assessment of the long-term impact of middle school activities, they will provide useful descriptive information on the progress the PSI students make in high school. Descriptive Analysis of Teacher Survey Data: WestEd will conduct descriptive analyses with teacher survey data to explore the program's impact on teachers' knowledge and practices as well as factors that facilitate or inhibit their ability to implement curriculum with fidelity. For example, we will calculate the percentage of teachers who report changes in STEM teaching practices as a result of taking part in the program.

Implementation Evaluation: The following questions will guide the implementation (formative) evaluation: (1) How and to what extent are the critical components of the PSI being implemented? (2) To what extent are students and teachers participating in project activities? [Is student participation helping develop a solid understanding of scientific concepts? Are teachers prepared to implement curriculum with fidelity?] (3) Which PSI activities are more engaging for students and specific subpopulations of students? (4) What are barriers to PSI implementation and student and teacher participation (at each level of the STEM delivery pyramid)? (5) What factors contribute to teachers' ability to implement the curriculum with fidelity? (6) Which PSI model elements are critical to effective teaching and positive student outcomes?

<u>Implementation evaluation framework</u>: Measuring implementation allows researchers to assess whether results that do not show a positive effect are due to the program model or incomplete implementation. Also, measuring implementation allows researchers to investigate which components are most related to positive outcomes. Although there is no consensus for an exact definition of fidelity of implementation, the evaluation team will rely on Century, Rudnick, and Freeman's (2010) definition: *The extent to which an enacted program is consistent with the intended program model*. The evaluators will determine PSI critical components (informed by the logic model), and whether and to what extent they are implemented by reviewing program documents and discussing the program with developers and users. The evaluation team proposes a modified version of Century et al.'s (2010) fidelity of implementation framework, specifically Structural-Procedural Critical Components (basic organizing elements of the program that reflect developers' intended design and organization, and communicate to participants *what to do)* and Structural-Educative Critical Components (basic content and pedagogical knowledge teachers need to have to implement the program). Findings from the summative and formative evaluation will be combined to identify factors that facilitate and impede program implementation and

participation, with the specific goal of identifying necessary components for sustainability and replication.

Implementation Analysis: The implementation evaluation will provide formative feedback to inform program development by providing data that enables continuous program improvement, improves service delivery, and enhances program outcomes. The implementation evaluation will provide timely feedback on PSI's key components, describing the implementation of PLTW curricula and measuring how well the program is moving toward meeting its key objectives based on project benchmarks and the logic model. The evaluation will include the collection, analysis and summary of student academic achievement data (annual), teacher surveys to assess implementation fidelity (biannual), records reviews to further examine the factors influencing curriculum implementation (annual), measures of student attitudes and engagement (biannual), and teacher participation (annual), as well as explore potential barriers and facilitators to the implementation of PLTW curricula and strategies (annual). Additionally, the professional development will be assessed using participant surveys. Finally, annual interviews will be conducted with district administration and treatment and comparison school principals to gain their perspective on implementation, impacts, systemic change, and sustainability.

Evaluators will use HLM involving only the PSI schools to investigate the association between implementation levels and student outcomes. These analyses will help understand whether certain components of the PSI program are more related to positive student outcomes and whether certain levels of implementation are needed to impact students. Analyses will use the Science CRT scores and student survey data as outcome variables and the same statistical controls as the outcome analyses. The key predictor variables in the implementation analyses will be student-level dosage measures and teacher-level implementation measures.

Case Study: WestEd will conduct a modified case study of a sample of students from the first implementation cohort (2013-14). In collaboration with program developers, we will identify a sample of students at 6^{th}-8^{th} grade in the first year of implementation, inclusive of English language learners and special education students, and annually administer a more extensive student survey and a home survey to gather richer contextual data on how program participation is influencing non-achievement student outcomes. In the third year of implementation, we will conduct focus groups with a subset of case study students and parents in order to further explore the influence of various program elements on student attitudes and behavior.

Reporting and Continuous Feedback: The evaluation will provide interim and annual reports on fidelity of implementation and outcomes. These reports will be structured to support continuous program improvement by highlighting successes and areas where implementation could be strengthened. The evaluator will submit an interim report to CCSD each August containing data from surveys and interviews administered during the previous year with the goal of providing data for improving implementation in the coming school year. CCSD will receive an annual report each December that provides comprehensive information on program implementation and outcomes for the year. This annual report will include data from the 8^{th} grade science CRT. The evaluator will work closely with the program director during the periods between the interim and annual reports to ensure continuous feedback is available to the program. About 9% of the PSI's budget is dedicated to evaluation, which is a sufficient amount to fund a project of this scope. Furthermore, an internal District evaluator will assist with data collection to minimize data-related costs and maximize WestEd's allocation of resources to other evaluation activities.