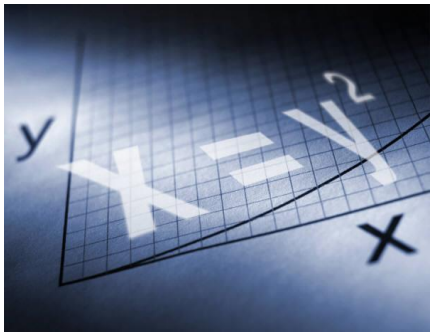
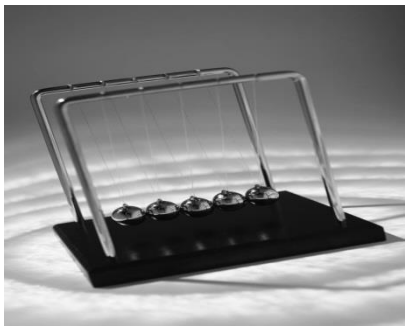
HARMONY

STEM PROGRAM





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PART I: Mission & Introduction

MISSION

Our mission at Harmony is to prepare each student for higher education by providing a safe, caring, and collaborative atmosphere featuring a quality, student-centered educational program with a strong emphasis on Science, Technology, Engineering, and Mathematics (STEM).

INTRODUCTION

Harmony Public Schools, a network of high-performing K-12 public charter schools across Texas (including in five metropolitan areas), focuses on providing science, computer technologies, engineering, and math education (STEM) to traditionally underserved students.

Our 24,000 students are diverse: 56% receive free or reduced price lunch and 80%+ are nonwhite (45% Hispanic, 19% African American, and 16% Asian). Harmony schools demonstrate that with a rigorous, high-quality program and the right social and emotional supports in place, all students, regardless of racial or economic background, can achieve outstanding results. Our schools consistently outperform regional and state averages in all four core subject areas and are making great progress in closing the achievement gap for minority and low-income students.

Harmony's leadership in STEM education has been recognized and supported by the State and private foundations working to expand and improve STEM education nationally.

Honors our schools have received include:

- National recognition with a $30 million federal grant in Fall 2012 (RTT-D Federal Grant) for initiatives to personalize learning and the Project Based Learning(PBL) Initiative
- Status as a Title I National Distinguished School for closing the achievement gap – US Department of Education
- *US News & World Report*'s "Best High Schools in the Nation" (2007-2012)
- Seven schools in *Newsweek*'s "America's Best High Schools" (2012), four of which were also in the "Top 25 Transformative High Schools" and "Top Ten Miracle High Schools"
- Four schools in this year's *The Washington Post*'s Challenge Index (based on student achievement on IB, AP, ACT, and SAT exams and graduation rates)

STEM at Harmony

Harmony's instructional approach strives for equity by providing a rigorous, challenging STEM curriculum serving all students, a focus on formative assessment, and a culture of high expectations and support. Harmony's STEM curriculum is student-centered and inquiry-based and matches the focus of the NGSS and College Ready Standards on rigor, depth, and higher-order skills such as conceptual understanding and application. In addition, we emphasize mastery of 21st century skills that all students will need to be successful in college and career.

Project Based Learning

Harmony's unique approach of implementing Project Based Learning (PBL) is a nationally recognized model. The Harmony approach is to maintain the focus on standards-based

and student-centered teaching while enriching and extending the learning of students through PBL projects. The goal is to promote not only collaborative skills and student ownership of learning but also to promote student success in state and national standards.

STEM Professional Development

Teacher quality is a key determinant of student achievement and strong content knowledge is crucial to effective teaching. Professional development is a key strategy for upgrading the skills of the existing teachers, particularly for teachers who newer to the field.

To date, efforts to improve the content knowledge and instructional practices of mathematics and science teachers have been limited in scope but very well received by teachers in the United States. HPS believes that professional development is a critical instrument toward ensuring the quality of teaching science and mathematics.

Our STEM training model has two major components: the mastery of content knowledge and the effective use of instructional practices. First we assess and enhance teachers' content knowledge, and then we move into improving their instructional practices.

STEM School Culture

The Harmony STEM approach also provides strategies and resources enabling schools to build a robust STEM culture that prepares students for college and career readiness. Such a culture creates a variety of opportunities for students to take STEM education "beyond the classroom" and see how today's instruction connects to career and lifelong learning. Examples

include campus-wide STEM festivals, science fairs, STEM Expo exhibitions, STEM related competitions, online student portfolios, internships, and career fairs.

HPS establishes a direct link between a strong STEM foundation and success in career. We have a strong record of perfect college acceptance (100%) and STEM field matriculation rate in which 65% of Harmony students choose STEM majors, compared to a national average of 33%.

PART II: Harmony Public Schools (HPS) Project Based Learning Initiative

■ PROGRAM OVERVIEW AND FRAMEWORK

The Project Based Learning initiative, launched during the 2013-2014 school year, addresses the increased need for students to acquire 21st century skills. Through Project Based Learning (PBL), students are exposed to deep learning experiences that are inquiry-based, student-centered, and integrated to the curriculum. The Harmony approach is to maintain the focus on standards-based and student-centered teaching while enriching and extending the learning of students through PBL projects. The goal is to promote not only collaborative skills and student ownership of learning but also to promote student success in state and national standards.

What is Project Based Learning?

Project Based Learning is an instructional approach that emphasizes collaboration and personalized learning. In project-based learning, student groups engage in meaningful inquiry that are of personal interest to them. These problems are real-life oriented, curriculum-based, and often interdisciplinary. Learners decide how to approach a problem and what activities or

processes they will perform. They collect information from a variety of sources, and then analyze, synthesize, and derive understanding from it.

The real-world focus of PBL activities is central to the process because it motivates students and adds value to their work. Their learning is connected to something real and involves life skills such as collaboration and reflection. Technology furthers the efforts of students and teachers in various phases of the PBL process.

At the end of the PBL, students demonstrate their newly acquired knowledge and are evaluated by how much they have learned and how well they communicate it. Students also conduct self-evaluation to assess their own growth and learning. Throughout this process, the teacher's role is to guide and advise students, rather than to direct and manage student work.

What are the components of Project Based Learning?

According to the Buck Institute for Education there are eight essential components of meaningful PBL experiences. These essentials are summarized below.

1. Significant Content: The project focuses on important knowledge and concepts derived from the standards and targets of essential understanding in the course. Students should find the content to be significant in terms of their own lives and interests. A well designed PBL experience is an effective vehicle for understanding content more deeply than by traditional methods such as lectures and textbooks.

2. A Need to Know*:* Teachers powerfully activate students' need to know by launching a project with an "entry event" that engages student interest and initiates questioning. The entry event can

be anything that sparks student inquiry such as a video, a discussion, a guest speaker, a field trip, a laboratory experience, etc. In contrast, announcing a project with a packet of papers will likely not create excitement and an atmosphere of active learning. Simply telling students that they should learn something because they will need it later does not motivate them. With a compelling student project, the reason for learning relevant material becomes personal and purposeful for the student.

3. A Driving Question: After discussion and brainstorming, students create a Driving Question to focus their efforts. A good Driving Question captures the heart of the project in clear, compelling language. The question should be provocative, open-ended, complex, and linked to the core of what we want students to learn. It could be abstract, concrete, or focused on solving a problem. The Driving Question allows students to understand why they are undertaking a project as well as the sequence of activities that ensues from their personal challenge.

4. Student Choice and Voice: Students' interest is captured by a challenging question that is selected and crafted by the students themselves. This provides the Student Choice to the project. The requirements of the project such as project report, digital and oral presentations, visual demonstrations, etc. provide Student Voice to the project. The Student Choice and Voice makes the project meaningful to the students. The stronger the Student Choice and Voice, the greater the ownership of the learning will be. However, projects should be designed with the extent of student choice that best fits each student. On the limited-choice end of the scale, learners can select what topic to study or choose how to design, create, and present products. As a middle ground, teachers might provide a limited menu of options to prevent students from becoming

overwhelmed by choices. On the "the more the better" end of the scale, students can decide what product they will create, what resources they will use, how they will structure their time, or even their topic and Driving Question.

5. 21st Century Skills: Collaboration is central to the PBL learning experience. A project should give students opportunities to build valuable 21st century skills such as collaboration, communication, critical thinking, and the use of technology, which will serve them well in the workplace and in life. Once students have decided on the Driving Question, they form teams of three or four and begin planning how they would work together. Each team regularly pauses to review their progress. Teachers can help grow these collaboration skills by using team building techniques and time/task organizers. Teachers in a Project Based Learning environment also assess these skills and provide frequent opportunities for students to assess themselves.

6. Inquiry and Innovation: Brainstorming as a class helps students generate new ideas and questions. Student team discussion allows opportunities to fine-tune their own Driving Question and to discuss resources and procedures. Students find project work to be more meaningful if they conduct real inquiry that begins with their own questioning, leads to a search for resources and the discovery of answers, and ultimately leads to generating new questions, testing ideas, and drawing their own conclusions. With real inquiry comes innovation – a new answer to a Driving Question, a new product, a new solution to a problem. Students are not expected to simply reproduce provided information in a pretty format. The teacher's task is to create the context for real inquiry in the classroom and to guide students through the process.

7. Feedback and Revision: As students develop their ideas and products, student teams use rubrics and exemplars to review and critique one another's work. The teacher checks research notes, reviews rough drafts and plans, and meets with teams to monitor their progress. The mentoring process of monitoring and feedback is formalized and structured so all student teams have guidance from their teacher throughout the duration of the project. Students learn through this mentoring that first attempts do not always result in high quality and that revisions are a frequent feature of real-world work. In addition to providing direct feedback, a teacher coaches students in using rubrics or other sets of criteria to critique one another's work. Teachers can arrange for experts or adult mentors to provide feedback, which is especially meaningful to students because of its source.

8. Publicly Presented Product: Student teams present their findings, conclusions, and solutions to audiences such as peers, parents, representatives of community, business, government organizations, and professionals from various industries. Students answer questions and reflect on how they completed the project, next steps they might take, and what they gained in terms of knowledge and skills and pride. When they present their work to a real audience, they connect to real life through their PBL projects. These projects become authentic when the process replicates real-life tasks and students are no longer observers but participants in real life experiences.

What is Standards-Focused PBL?

There is no one accepted definition of PBL. However, the Buck Institute for Education (BIE) defines standards-focused PBL as ***a systematic teaching method that engages students in learning knowledge and skills through an extended inquiry process structured around***

complex, authentic questions and carefully designed products and tasks. This definition encompasses a spectrum ranging from brief projects of one to two weeks based on a single subject in one classroom to year long, interdisciplinary projects that involve community participation and adults outside the school.

More important than the definition itself are the attributes of effective projects. You will find that the BIE planning model is based on a number of criteria that distinguish carefully planned projects from other extended activities in the classroom. Outstanding PBL projects:

- Recognize students' inherent *drive to learn*, their capability to do important work, and their need to be taken seriously by placing them at the center of the learning process.
- Engage students in the central concepts and principles of a discipline. The project work is *central* rather than peripheral to the curriculum.
- Highlight provocative issues or questions that lead students to *in-depth exploration of authentic and important topics.*
- Require the use of essential *tools and skills* for learning, including technology, self-management, and project management.
- Specify *products* that solve problems, explain dilemmas, or present information generated through investigation, research, or reasoning.
- Include *multiple products* that permit frequent feedback and consistent opportunities for students to learn from the experience.
- Use *performance-based assessments* that communicate high expectations, present rigorous challenges, and require a range of skills and knowledge.
- Encourage *collaboration* in some form, either through small groups, student-led presentation, or whole-class evaluations of project results.

The BIE model for PBL also addresses a singular need in the field of PBL: to create *standards-focused* projects that fit well within an environment of accountability and performance. Often projects have been used as fun or change-of-pace events completed after students have been pushed through homework assignments, lectures, and tests**.**

In standards-based PBL, students are pulled through the curriculum by a Driving Question or authentic problem that creates a need to know the material. The Driving Question is tied to content standards in the curriculum, and assessment is explicitly designed to evaluate the students' knowledge of the content.

Similarly, Project Based Learning is sometimes equated with inquiry-based or experiential learning. Though PBL shares some overlapping characteristics with these two terms, standards-focused PBL is designed to acknowledge the importance of standards and evaluation of student learning. In an environment of accountability, with testing and performance uppermost in the minds of parents and educators, it is imperative that all instructional methods incorporate high standards, rigorous challenges, and valid assessment methods.

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Larmer, J., Mergendoller, J. (2010). 8 Essentials for Project-Based Learning. Retrieved from http://www.bie.org/tools/freebies/Project Based Learning for the 21st Century

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HPS PBL Framework

The Harmony PBL program customizes and individualizes the PBL experience for its students while incorporating the research from successful PBL programs into the its design and structure. Technology is integrated into every phase to enable students to progress and complete PBL projects successfully while learning life skills. The STEM focus of the Harmony PBL program allows the growth and acquisition of 21st Century skills. A framework of the Harmony Public Schools PBL program for middle and high school is shown below.

Middle School Framework

Levels	Content/Courses	# of Projects	Allotted Time	Structure	Technology Integration
Level I	English	1 Project each Semester	1 week	Group work (3-4 students per group)	Digital Photo Gallery Presentation (optional)
	Math	1 Project each Semester	1 week	Group work (3-4 students per group)	1 Digital Photo Gallery Presentation per year
	Social Studies	1 Project each Semester	1 week	Group work (3-4 students per group)	Digital Photo Gallery Presentation (optional)
	Science	1 Project each Semester	1 week (may be done in small increments throughout a period of two weeks)	Group work (3-4 students per group)	1 Digital Photo Gallery Presentation per year
Level II	Math/Science /Engineering	1 Holistic Project each Year	Year long	Individual work	1 Video Presentation + (HPS Digital Contest)

High School Framework

Levels	Content/Courses	# of Projects	Allotted Time	Structure	Tech. Integration
Level I	English	2 Projects each Semester	1 week	Group work (3-4 students per group)	Digital Photo Gallery Presentation (optional)
	Math	2 Projects each Semester	1 week	Group work (3-4 students per group)	1 Digital Photo Gallery Presentation per semester
	Social Studies	2 Projects each Semester	1 week	Group work (3-4 students per group)	Digital Photo Gallery Presentation (optional)
	Science	2 Projects each Semester	1 week	Group work (3-4 students per group)	1 Digital Photo Gallery Presentation per semester
Level II	Math/ Science with integrated ELA ,Social Studies,& Technology	1 Inter-disciplinary Project each Year	Year long	Individual work	Presentation through video, website and brochure + (HPS Digital Contest)
OR **Level III**	Math/ Science with integrated ELA ,Social Studies,& Technology	1 Inter-disciplinary Project each Year	Year long	Individual work	Presentation through video, website and brochure + (HPS Digital Contest)

■ HARMONY PBL APPROACH AND PBL LEVELS

Students experience PBL projects at various levels: Level I is a short term project and targets 21st century skills within the context of the curriculum, while Level II & Level III are year-long interdisciplinary projects allowing the application and development of these critical skills.

Outlined below is a description of the Harmony Public Schools PBL initiative for middle and high school.

Middle School PBL Levels

Middle school students work with two different levels of PBL projects.

Level I

In each core subject (English, Math, Social Studies, and Science), middle school students complete at least one PBL project in class each semester. Some of the major features of the Level I PBL projects are outlined below.

- The projects are based on the standards covered within the context of the curriculum as described by the scope and sequence of the course.
- The projects are conducted as in-class group projects. Student groups of 3-4 students are recommended.
- The time required for completion of projects is no more than one week.
- PBL teacher guides as well as training for effective planning and integration of the PBL projects into the curriculum are provided at the start of the school year.
- Teachers will provide students in a timely manner with relevant information, timelines, documents, assessment rubrics, and guidance for the successful completion of projects.
- Upon completion of a project, students will produce a digital presentation of their work.
- Project assessment is completed in each of the core content areas by the respective teachers using provided rubrics.

Level II

In addition to the Level I projects outlined above, each student completes one Level II PBL/STEM research project based on math, science, or engineering content. Some of the major features of the Level II PBL projects are outlined below.

- The project focus or question will be assigned by the teacher at the beginning of school year.
- Students will begin project work in the first semester and work will continue through the second semester.
- Teachers will provide students in a timely manner with relevant information, timelines, documents, assessment rubrics, and guidance for the successful completion of projects.
- Upon completion of project, students will produce a digital presentation of their work.
- Project assessment will be completed in math/science content areas by the respective teachers using provided rubrics.

High School PBL Levels

High school students work with three levels of projects. All students will complete Level I projects, followed by either a regular Level II or an advanced Level III project.

Level I

In each core subject (English, Math, Social Studies, and Science), students will complete two PBL projects in class each semester. Some of the major features of the Level I PBL projects are outlined below.

- The projects are based on the standards covered within the context of the curriculum as described by the scope and sequence of the course.
- The projects are conducted as in-class group projects. Student groups of 3-4 students are recommended.
- The time required for completion of projects is no more than one week.
- PBL teacher guides as well as training for effective planning and integration of the PBL projects into the curriculum will be provided at the start of the school year.
- Teachers will provide students in a timely manner with relevant information, timelines, documents, assessment rubrics, and guidance for the successful completion of projects.
- Upon completion of project, students will produce a report of their work and digital presentation of the project.
- Project assessment is completed in each of the core content areas by the respective teachers using provided rubrics.

Level II

In addition to the Level I project described above, each student completes one interdisciplinary PBL/STEM type project based on math or science content. These math or science projects also contain integrated social studies and ELA components.

Some of the major features of the Level II PBL projects are outlined below.

- The project focus or question is selected by the student from a list of 20-25 investigations in math or science. This list of topics of study will be provided by the teacher at the beginning of school year.
- Students begin project work in the first semester and work will continue through the second semester.
- Teachers will provide students in a timely manner with relevant information, timelines, documents, assessment rubrics, and guidance for the successful completion of projects.
- Communication between students and teachers throughout the project occur via a Google site specifically created for this purpose.
- Upon completion of project, students will present their findings through a short presentation video and/or web content.
- Project assessment is completed in each of the content areas (math/science, social studies, ELA, and technology) by the respective teachers using provided rubrics.

Level III

Level III projects are options for students who enjoy the challenge of creating and conducting their own project. Some of the major features of the Level III PBL projects are outlined below.

- Level III projects are multidisciplinary. These projects incorporate and address each core content area using integrated technology.
- The content and quality of project must be appropriate for high school and deserving of advanced credit.

- The project must follow ethical guidelines and must be conducted using routinely accessible materials.
- Parameters of the project such as the Driving Question, guidelines, and expectations are drawn up collaboratively between student and teacher. Students submit project proposals for approval before they start.
- Teachers will provide students in a timely manner with relevant information, timelines, documents, assessment rubrics, and guidance for the successful completion of projects.
- Project assessment is completed in each of the content areas (math/science, social studies, ELA, and technology) by the respective teachers using provided rubrics.

PART III: STEM Professional Development

Harmony offers intensive and ongoing teacher training for STEM teachers. The Harmony STEM training model has two major components: the mastery of content knowledge and the effective use of instructional practices. First we assess and enhance teachers' content knowledge, and then we move into improving their instructional practices. Teachers receive the following general trainings before they enroll into content-based trainings related to their subject:

- 5E Model Training (6 hours)
- Curriculum Framework/Standards Training (6 hours)
- Inquiry Based Lab Training (6 hours)
- PBL Training (12 hours)
- Data Collection Tools Training (Pasco or Vernier) (6 hours)
- TI Calculator Training (6 hours)

After they complete those general trainings, teachers receive the series of content-focused training modules. Teachers can complete the modules and general training sessions either through attendance at a 5-day summer training or via workshops offered throughout the year by the HPS central office.

Completion of each module requires mastery of content and a predetermined number of hours of practice on various strategies emphasized in general sessions. Teachers take tests to prove content mastery. The mastery tests are targeted both to measure content knowledge and to eliminate common misconceptions.

Teachers attend face-to-face workshop sessions to practice effective delivery of the content. In these workshops, teachers practice various teaching strategies such as PBL, 5E lessons, Inquiry labs, technology labs, etc. in teacher/teacher and teacher/student modes.

Part IV: STEM School Culture

■ STEM Approach

Harmony maintains a comprehensive approach to STEM education. This approach can be found in the everyday school culture, integrated into curriculum, and highlighted during campus-wide STEM events. Harmony communicates its STEM efforts to its stakeholders and actively plans partnerships and outreach activities. Harmony's flagship events, I-SWEEEP and STEM Education Week, represent the celebration and culmination of Harmony STEM.

Harmony's beliefs on STEM education are as follows:

a. School-wide STEM - "Every Harmony student is a STEM advocate."

Harmony targets the entire student body for STEM education and embraces a school-wide STEM approach. STEM is not only for those who have an interest or skill to pursue STEM majors. The "Every Harmony student is a STEM advocate" approach allows students, regardless of their ability and major interest, to engage and experience success with STEM, increase their STEM awareness, and become STEM advocates.

b. Share and Shine

Harmony STEM believes that students become actively engaged in STEM, sharing their work in collaborative and social settings, and shining through presentations, displays, and competitions. The Harmony STEM Share and Shine approach makes STEM engagement socially desirable for students.

c. Technology Integration

Harmony STEM employs technology integration that complies with 21st century standards. Harmony STEM acknowledges the role of technology literacy in mastery of content knowledge, development of scientific inquiry and mathematical processes, and interdisciplinary projects.

i. Students use technology as they conduct their research, communicate and collaborate with others, and present their final products, e.g. video clip, online student portfolio, etc.

d. STEM Compliance with T-STEM Benchmarks

Harmony complies with national or statewide standards put in place by STEM organizations. Harmony STEM has embraced the T-STEM benchmarks as a powerful framework in developing a school-wide STEM culture. Harmony values and acknowledges the leadership of Educate Texas in STEM Education in Texas.

■ STEM INTEGRATED INTO CURRICULUM

Harmony students are exposed to deep learning experiences through various STEM programs that are integrated to the curriculum such as the Project Based Learning (PBL) initiative (see Sections II & III), a large spectrum of science, engineering, math, and technology course offerings, and opportunities for research and competition.

a. Project Based Learning(PBL) Integration to Curriculum

Harmony's PBL approach is to maintain the focus on standards-based and student-centered teaching while enriching and extending the learning of students through PBL projects. Students experience PBL projects at three levels: Level I is a short term project and targets 21st century skills within the context of the curriculum, while Level II & Level III are year-long interdisciplinary projects and allow the application and development of these critical skills.

Outlined below is a description of the Harmony Public Schools PBL initiative for middle and high school.

Middle School Integration

Middle school students work with two different levels of PBL projects.

Level I

In each core subject, (English, Math, Social Studies, and Science), middle school students complete at least one PBL project in class each semester. Some of the major features of the Level I PBL projects are outlined below.

- The projects are based on the standards covered within the context of the curriculum as described by the scope and sequence of the course.
- The projects are conducted as in-class group projects. Student groups of 3-4 students are recommended.
- The time required for completion of projects is no more than one week.
- PBL teacher guides and training for effective planning and integration of the PBL projects into the curriculum are provided at the start of the school year.
- Teachers will provide students in a timely manner with relevant information, timelines, documents, assessment rubrics, and guidance for the successful completion of projects.
- Upon completion of project, students will produce a digital presentation of their work.
- Project assessment is completed in each of the core content areas by the respective teachers using provided rubrics.

Level II

In addition to the Level I projects outlined above, each student completes one Level II PBL/STEM research project based on math, science, or engineering content. Some of the major features of the Level II PBL projects are outlined below.

- The project focus or question will be assigned by the teacher at the beginning of school year.
- Students will begin project work in the first semester and work will continue through the second semester.
- Teachers will provide students in a timely manner with relevant information, timelines, documents, assessment rubrics, and guidance for the successful completion of projects.
- Upon completion of project, students will produce a digital presentation of their work.
- Project assessment will be completed in math/science content areas by the respective teachers using provided rubrics.

High School Integration

High school students work with three levels of projects. All students will complete Level I projects, either a regular Level II or an advanced Level III project.

Level I

In each core subject, English, Math, Social Studies, and Science, students will complete two PBL projects in class each semester. Some of the major features of the Level I PBL projects are outlined below.

- The projects are based on the standards covered within the context of the curriculum as described by the scope and sequence of the course.
- The projects are conducted as in-class group projects. Student groups of 3-4 students are recommended.
- The time required for completion of projects is no more than one week.
- PBL teacher guides and training for effective planning and integration of the PBL projects into the curriculum will be provided at the start of the school year.
- Teachers will provide students in a timely manner with relevant information, timelines, documents, assessment rubrics, and guidance for the successful completion of projects.
- Upon completion of project, students will produce a report of their work and digital presentation of the project.
- Project assessment is completed in each of the core content areas by the respective teachers using provided rubrics.

Level II

In addition to the Level I project described above, each student completes one interdisciplinary PBL/STEM type project based on math, or science content. These math or science projects also contain integrated social studies and ELA components. Some of the major features of the Level II PBL projects are outlined below.

- The project focus or question is selected by the student from a list of 20-25 investigations in math or science. This list of topics of study will be provided by the teacher at the beginning of school year.

- Students begin project work in the first semester and work will continue through the second semester.
- Teachers will provide students in a timely manner with relevant information, timelines, documents, assessment rubrics, and guidance for the successful completion of projects.
- Communication between students and teachers throughout the project occur via a Google site specifically created for this purpose.
- Upon completion of project, students will present their findings through a short presentation video and/or web content.
- Project assessment is completed in each of the content areas (math/science, social studies, ELA, and technology) by the respective teachers using provided rubrics.

Level III

Level III projects are options for students who like the challenge of creating and conducting their own project. Some of the major features of the Level III PBL projects are outlined below.

- Level III projects are multidisciplinary. These projects incorporate and address each core content area using integrated technology.
- The content and quality of project must be appropriate for high school and deserving of advanced credit.
- The project must follow ethical guidelines and must be conducted using routinely accessible materials.

- Parameters of the project such as driving question, guidelines, and expectations are drawn up collaboratively between student and teacher. Students submit project proposals for approval before they start.
- Teachers will provide students in a timely manner with relevant information, timelines, documents, assessment rubrics, and guidance for the successful completion of projects.
- Project assessment is completed in each of the content areas (math/science, social studies, ELA, and technology) by the respective teachers using provided rubrics.

b. STEM Pathways

In addition to regular course work and College Board Advanced Placement (AP) Courses, Harmony Public Schools offer a variety of STEM pathways for high school students. Students choose a pathway to follow in their freshman year and complete 4 years of course work. HPS offers four main STEM pathways:

- Information Technology - Programming
- Information Technology - Interactive Media
- Engineering
- Biomedical Sciences

Additionally, Harmony schools utilize some of the nation's best STEM programs as a part of the curriculum. The *Project Lead the Way (PLTW) - The Gateway to Technology* program is offered in our middle schools and high schools. *Pathway to Engineering* is available in our high schools. *The Infinity Project* by Southern Methodist University is implemented as an engineering program at some of our middle schools and high schools.

Please see the chart below that summarizes the options for STEM tracks.

Option A	Option B
Information Technology (CTE) - Programming	**Technology Applications - Programming**
Principles of Information Technology	Fundamentals of Computer Science
Computer Programming	Mobile Application Development
Advanced Computer Programming	Robotics Programming and Design
AP Computer Science A	Game Programming and Design
	Digital Art and Animation (Fine Arts Credit)
Information Technology (CTE) - Interactive Media	
Principles of Information Technology	
Digital and Interactive Media	
Web Technologies	
Audio Video Production	
PLTW - Pathway to Engineering (CTE)	**STEM (CTE) - Engineering**
Introduction to Engineering Design (IED)	Concepts of Engineering and Technology
Principles of Engineering (POE)	Engineering Design and Presentation
One Specialization Course	Advanced Engineering Design and Presentation
Engineering Design and Development (EDD)*	Engineering Design and Problem Solving
PLTW - Biomedical Sciences (CTE)	**STEM (CTE) - Biotechnology**
Principles of Biomedical Science (PBS)	Concepts of Engineering and Technology
Human Body Systems (HBS)	Biotechnology
Medical Interventions (MI)	Advanced Biotechnology
Biomedical Innovation (BI)	Scientific Research and Design

- ✓ *Curriculum materials for these courses can be accessed at www.harmonytx.org/curriculum(access permission credentials will be required).*

c. STEM as Part of GT/Honor Program

The HPS Science curriculum incorporates project-based learning at multiple levels. It requires students to perform self-initiated research using scientific inquiry and experimentation.

Science Research and Participation in Regional/State Fairs

In middle school, all students complete research projects as a part of PBL Level-2. Successful projects are selected through campus-wide science fairs for students to continue their research by participating at regional, state, national, and international levels to compete with other projects. To produce more advanced projects, HPS helps potential middle school students to connect with research groups at local universities and labs.

In high school, students experience the scientific method as part of the Scientific Research and Design curriculum. Students taking this course are connected to higher education institutions and submit a paper at the end of the year to receive credit. Students successfully conducting PBL Level-3 projects may continue their research by competing at science fairs. HPS connects these students with professors and researchers at local universities for more in-depth research.

Harmony students participate in the following science research competitions;

- INTEL ISEF Affiliated Regional and State Science Fairs
- International I-SWEEEP Science Project Olympiad organized by Harmony Public Schools in Houston, TX (www.isweeep.org)

- Intel International Science and Engineering Fair organized by Society for Science and the Public (www.societyforscience.org/isef/)
- Google Science Fair (www.googlesciencefair.com)

Robotics Program/ Robotics Competitions

The objective of the Robotics program is to foster interest and competence in science, mathematics, and computers while promoting problem-solving skills, enabling creative thinking and design, and providing a domain for the application of scientific concepts. Students learn and apply the scientific, mathematical, and technological fundamentals behind the construction of robots and the design of control algorithms. They also develop some daily life skills as they build robotic creations, such as visual reasoning, problem solving, teamwork, cooperation, and self-discipline.

Technology teachers and qualified parents serve as mentors during the robotics events at the schools. Technology teachers receive intensive summer training to develop robotics teams on their campuses. The HPS Technology Applications department provides curriculum, resources, and training to the teachers, utilizing the following curriculum resources, robotics kits, and software described below.

Curriculum:

- Robotics Engineering Vol. I - Introduction to Mobile Robotics
- Robotics Engineering Vol. II – Guided Research
- TETRIX Curriculum
- RobotC Curriculum for TETRIX
- Autodesk's VEX Robotics Curriculum

Robotics Kits:

- LEGO Mindstorms Education Base Set
- LEGO Education Resource Set
- TETRIX® Set by Pitsco
- VEX Robotics Sets

Robot Programming Software:

- NXT-G –graphical programming
- ROBOTC
- EasyC
- LabVIEW

Participation in Robotics Events

Robotics teams engage in various Robotics events, both external and in-house (organized by Harmony Public Schools). Students compete in various contests and participate in STEM exhibitions and conferences to demonstrate and present their work.

In-house Robotics Activities

The following events and competitions have been organized and carried out by the Harmony system.

- **Harmony Early Robotics**

  Engineering And Robotics Learned Young (EARLY) is a program that exposes our youth to engineering. EARLY provides 7 to 12 year olds the opportunity to participate in a robotics competition every fall and spring. (http://www.harmonyearly.org/

- **Harmony Robo League - Official First Lego League Competition (Fort Worth cluster)**

  A mission similar to those of FLL on a rectangular field.

  http://www.harmonyroboleague.org

- **Official Southwest FLL Championship (Texas / New Mexico)**

  Organized by Harmony School of Innovation - El Paso

  https://hsielpaso.org/southwest/

- **Cosmobot Robotics Competition - May (Houston)**

  Autonomous robots compete against each other in a sumo-wrestling inspired battle on a circle field.

  http://cosmobot.cosmostx.org/

External Events

- FLL, FTC, FRC (www.usfirst.org)
- Best (http://www.bestinc.org)

- Vex (http://www.vexrobotics.com/)
- Ecobot (http://www.ecobotchallenge.com, http://robotevents.com)

MATHCOUNTS

MATHCOUNTS is a national enrichment, club, and competition program that promotes middle school mathematics achievement through grassroots involvement in every U.S. state and territory. MATHCOUNTS is one of the country's largest and most successful education partnerships involving volunteers, educators, industry sponsors, and students.

Harmony Public Schools participate in the MATHCOUNTS program at the regional and state levels, preparing students for these competitions through MATHCOUNTS Clubs as part of the Gifted and Talented Program. Harmony students generally outperform at regional and state levels and enjoy a great success record at national level MATHCOUNTS.

The schools utilize pull-out schedules and after school programs to operate the MATHCOUNTS Clubs. The HPS Math department provides resources and training for teachers who coach the clubs.

■ CAMPUS-WIDE STEM EVENTS

a. STEM Festivals

The goal of STEM festivals is to stimulate the interest of our students, parents, and the public in STEM by organizing fascinating, exciting, educational, and entertaining activities in our schools. Each year, all Harmony high school campuses organize a STEM festival to showcase students' various STEM products. Local influential

people, parents, and the public are invited to STEM festivals as we celebrate the success and hard work of our students.

Students present a variety of STEM projects in these festivals some of which include;

- Year-long PBL projects
- Science Research and Engineering Projects
- Exciting STEM demonstrations , hands-on activities, and experiments
- Robotics shows

The HPS Academic Department provides necessary guidelines, training, resources, and support to the schools for a successful event organization. Some of these resources are as follows:

- Guidelines for school administrators and campus STEM coordinators
- Sample flyers in editable format
- Information on how to broadcast through Google Hangout and YouTube
- Sample floor plan for various activities
- STEM festival photo albums from campuses

All resources can be found at www.stem-fest.us, developed by the HPS Academic Department to support STEM teachers and administrators.

b. Campus-wide STEM Competitions

School-wide Science Fair

Each year, all Harmony middle school campuses organize a campus-wide science and engineering fair in which students display their year-long science research projects and compete against their peers. Local influential people, parents, and the public are invited to visit the fair. Schools also invite engineers, doctors, educators, and other professionals to judge the students' projects.

The HPS Academic Department provides necessary guidelines, training, resources, and support to the schools for a successful event organization.

STEM Activity Competitions

In addition to STEM festival and science fair organization, interested students participate in various STEM competitions throughout the school year. These events take place as part of the after-school program. Students join the contests individually or in teams. Some of the competitions include:

- Spaghetti Bridge
- Popsicle Stick Bridge
- Mousetrap Car Race
- Water Rocket
- Tower Building
- Water Rocket Car
- Motor Man

- Scientific T-Shirt Design
- Science Photo Contest
- Hatching Egg Activity
- Insect Collection Activity

The HPS Academic Department provides teachers with resources for the organization of these competitions and activities. These resources can be found at the www.harmonyphysics.com website.

Online Technology Contests

- **Website design contest**

  As the high school students work on their PBL projects, they develop a website about their projects. Upon the completion of their website, their teachers can submit these website designs to the HPS website contest that includes different categories such as science, math, engineering, and technology. Each school organizes a campus-wide contest as well. More information can be found at www.stemcontest.com.

- **Video Production Competition**

  Each middle and high school student prepares their digital presentation in video format. Upon the completion of their product, students can participate in the HPS video production contest. There are also campus-wide video production competitions during the year.

- **Science/Math Photo Contests**

  These contests are held on some campuses. Winners also participate in nationwide photo contests like the AAPT High School Physics Photo Contest (http://www.aapt.org/programs/contests/photocontest.cfm).

c. Clubs and After-School STEM-day Celebrations

- **STEM Clubs:** These after-school clubs provide students with opportunities to improve their STEM projects with extensions, present their PBL projects in school days, and prepare journals, photo albums, posters, and movies of STEM activities in the school.

- **STEM-day Celebrations:** These are subject-specific, week-long events such as Mole Day, Pi (π) Day, Physics Week, and Biology Week. During those days, each department organizes different activities and competitions on campus. They can also be considered as STEM-day celebrations or preparation times for STEM festivals.

d. STEM Summer Camps

STEM summer camps are held as part of leadership camps during the summer. Several fun and hands-on activities are planned for students to engage them in STEM.

■ STEM COMMUNICATION

Harmony Public Schools (HPS) recognizes that communications is a critical element toward ensuring the success of STEM programs within the schools. HPS believes that communication is the key element in sustaining the STEM programs at our schools by making all stakeholders including parents, staff, administrators, students, and the community believe in the importance of content-rich STEM curricula.

HPS provides high quality STEM education to support economic development since there is a strong link between STEM education and economic vitality. HPS will continue to champion rigorous and relevant STEM education for all students by adopting innovative approaches.

HPS uses a strategic communication plan to support and promote HPS STEM programs targeting all stakeholders. The following strategies are adopted to secure effective communication regarding STEM programs.

STEM Website

Although it is considered challenging to reach all stakeholders at once with equal strength, a comprehensive STEM website is used as a tool to disseminate the STEM message publicly. It is important that the STEM website have features that are updated regularly. A comprehensive STEM website contains most of the following menu items if not all.

- **About:** Introductory statement of the organization including mission, vision, and STEM efforts is shared publicly at this section that serves as a reference point.

- **STEM Programs:** The STEM curriculum documents (including guides, scope and sequence, unit plans, sample lesson plans, and additional resources) are uploaded at the STEM website for easy access by all stakeholders at all levels. Harmony Public Schools use the STEM websites as a STEM library to maximize the benefit from curriculum resources and documents.

- **STEM Activities:** HPS believes in the necessity of the "Share and Shine" approach in promoting the STEM education. STEM activities of any kind are promoted on this section publicly. STEM stories, STEM field trips, STEM speakers, STEM programs, and STEM classroom activities are shared under this section.

- **STEM Partnerships:** Collaboration and partnerships are key elements in sustaining and promoting STEM education. This section serves as a tool for building and improving the STEM network for the organization. Community businesses, governmental agencies, local educational agencies, higher education institutes, and industrial corporations are listed here as partners for STEM education. Partnerships and affiliations fall under this section as well.

- **STEM Resources:** Resources for teachers, parents, and students are shared publicly in order to support STEM education. This section is open to any type of resource including video libraries and links to other STEM resources. Parents, students, and faculty are directed to information on STEM-related websites, resources, careers, college programs, community partnerships, STEM projects, and scholarship

opportunities.

- **STEM Showcase:** The HPS "share and shine" approach requires a showcase for STEM activities and STEM efforts. Best practices are shared in various formats including videos, picture presentations, or featured articles. Because this section is considered a very dynamic part of the website, the showcase needs to be updated with new material at least weekly, if not daily.

- **STEM Research:** It is critical to support STEM education with the latest research. Reports, newspaper articles, or journal articles related to STEM are shared under this tab in accordance with the relevancy of the research.

- **STEM Competitions:** Participation in STEM competitions is encouraged due to HPS' strong emphasis on hands-on and inquiry-based learning activities. HPS encourages students to participate in local, regional, and national STEM competitions such as science fair, MATHCOUNTS, science Olympiad, robotics, etc. Brief information regarding STEM competitions along with links to additional information serve as a guide to increase participation in STEM competitions. These STEM competitions are advertised to encourage participation and involvement by sharing previous experiences in STEM-related competitions.

- **STEM Conferences:** It is crucial to be involved in scholarly conversations with members of STEM community, and STEM conferences can be a great platform for

sharing innovative ideas, best practices, and possible solutions to common problems. STEM conferences build and support effective STEM networks to prioritize high-quality STEM education improvement and the college-readiness of all high school graduates. **Contact:** Contact information for STEM personnel is shared for easier and better communication.

STEM newsletter

Besides the STEM website, HPS shares STEM messages with its target audience via monthly newsletter. Best practices are shared which exemplify ways to make schooling more interesting and relevant for our students. Registration information about upcoming events and conferences are included in the newsletter along with articles over STEM that link to college readiness, robotics activities, and engineering. The newsletter contains core messages for students and parents such as "STEM education prepares HPS students for success in postsecondary education and careers." STEM-specific data are shared within the newsletter in order to illustrate the importance of relevant STEM education such as high school student enrollment patterns in AP and dual credit courses, trends in AP and SAT scores, data on the number of students pursuing STEM careers, data on demand for STEM workforce, etc. The STEM newsletter is a great tool to communicate issues regarding high-quality STEM education and to justify how everyone benefits from a strong STEM education system.

Social network, e.g. Facebook, Twitter, YouTube, etc.

Social media is used effectively and heavily to keep the STEM communication exciting. Different types of news regarding high quality STEM education is shared daily with the

audience. Innovations, advancements in technology, local and regional STEM events, and announcements are considered part of daily social media materials. These tools integrate younger generations with STEM education as they are more technologically savvy than adults.

HPS uses Twitter, Facebook, YouTube, and blogs to spread the word.

STEM Presentations to School Visitors

HPS utilizes STEM presentations to school visitors to establish a network of supporters and advocates for STEM education through outreach activities. HPS establishes VIP teams at campus level formed by students who display their STEM skills through demonstrations, experiments, projects, and activities to school visitors. These presentations may take place in science labs or robotics labs. It is very important to link classes of today with careers of tomorrow during these presentations.

■ STEM PARTNERSHIPS AND OUTREACH

Harmony STEM emphasizes the role of partnerships and outreach activities in the development of STEM culture. The following programs make unique contributions to STEM culture in our schools.

Partnerships & Collaboration with Academia, T-STEM Centers, Industry, & Community

Harmony STEM partners with T-STEM centers, colleges, and universities in the areas of mentoring, research, professional development, and dual credit courses. Industry and community partners provide internship, service learning opportunities, and support for other projects.

STEM Expo and Presentations in Major Events Such as Conferences, Legislative Sessions

Harmony STEM seizes every opportunity for its students to showcase their work and provide STEM outreach and advocacy to their peers, educators, and legislators. Students interact with the community in a STEM context through STEM Expo events, exhibits, and presentations.

I-SWEEEP Public Day and Harmony EARLY, a State-Wide Robotics Competition

I-SWEEEP (International Sustainable World Energy Engineering Environment Project Olympiad), a Harmony flagship event, opens its doors to the public every year. In addition to display of research projects, the I-SWEEEP Public Day consists of several events including the "Harmony EARLY" Robotics Competition, over one hundred astonishing science demonstrations and activities, and amazing chemistry shows.

Flagship Events

Our nation has been at the forefront of science and innovation for the past century. However, in recent years, the reach of STEM education has not kept pace with an increasing workforce demand. Jobs requiring math and science are increasing four times faster than overall job growth (Program for International Student Assessment test, 2004).Within this context, our nation faces a unique workforce challenge, a challenge which Harmony addresses through two significant STEM events.

a. The International Sustainable World Energy, Engineering, & Environment Project (I-SWEEEP) Olympiad

I-SWEEEP is a groundbreaking science, technology, engineering, and math (STEM) competition open to students in grades 9-12. I-SWEEEP, the largest science fair event of its kind, brings over 600 of the best and brightest STEM-focused minds from across the nation and the world annually to celebrate innovation in research and science.

I-SWEEEP is organized by Harmony Public Schools in collaboration with K-12 public school systems, business and industry, and higher education institutions.

By assembling the best and brightest STEM students alongside STEM professionals from business, higher education, and government institutions, I-SWEEEP serves as a bridge between STEM talent and STEM careers, creating an intellectual talent pipeline for Energy, Engineering, and Environment-related careers, raising awareness about and encouraging students into these critical areas of the workforce (see *Theory of Change* chart at the bottom of this section).

I-SWEEEP is at the forefront of bringing together young STEM-minded prospective researchers. Since its initiation in 2008, it has celebrated the following:

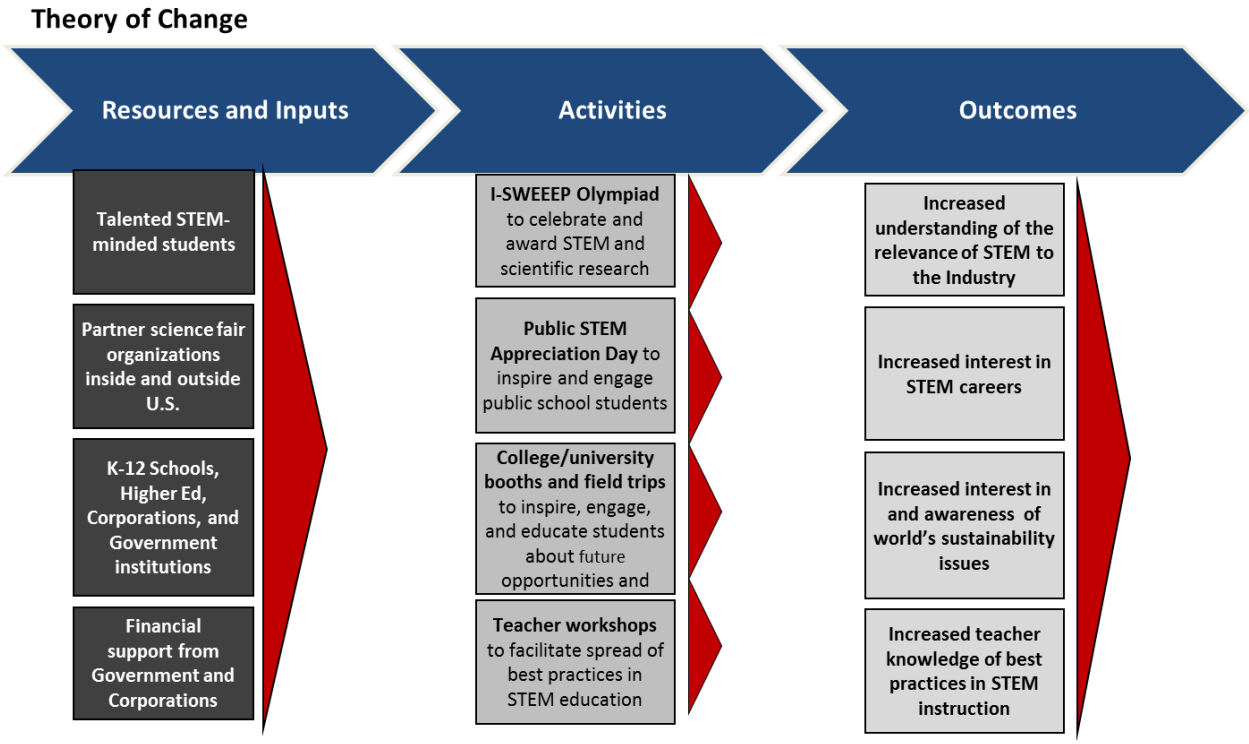
- 1,161 domestic projects presented by 1,615 U.S. students
- 736 international projects presented by 1,032 international students from 70 countries

I-SWEEEP acts as a liaison between STEM talent-seeking government institutions and corporations and top talented STEM-minded high school students, in order to encourage those students to choose STEM-related pathways in college and seek employment within the STEM workforce after graduation.

I-SWEEEP has affiliation agreements with 178 state and regional science fair organizations in the U.S. as well as 80 national science fair organizing institutions outside the U.S., attracting top-tier projects and talents to I-SWEEEP after qualifying in their respective science competitions. Individuals can also submit outstanding projects directly to I-SWEEEP; these applicants undergo an extensive selection process by a panel of academicians and scientists before being invited to participate (on average, 10% of projects submitted independently are invited to compete at I-SWEEEP). All projects are required to involve authentic research practices to ensure quality and innovation.

Qualifying students assemble in Houston in May. The I-SWEEEP Olympiad is a five-day celebration of science that facilitates future scientists, engineers, and policy makers from different corners of the world and nation in learning about each other's research and getting to know one another. Students gain new understandings and perspectives as they are exposed to each other's research and cultures.

Projects are judged by more than 250 industry professionals from companies such as BP, Shell, and KBR, as well as faculty and doctoral students from area universities including Rice University and the University of Houston. Winners receive not only a medal for their efforts, but also scholarships from universities.



More information on I-SWEEEP can be found at www.isweeep.org.

b. STEM Education Week : A Celebration of STEM Education

In addition to I-SWEEEP project competition, Harmony provides an exciting and engaging setting for Public STEM Education Week which takes place in the week of I-SWEEEP. It is designed to advance STEM education and raise public awareness and interest. The following are main events in this week.

STEM EXPO for Public and K-12 Students on I-SWEEEP Public Day

Each year, more than 4,000 K-12 public school students and teachers from diverse backgrounds visit the I-SWEEEP Public Day and enjoy exposure to exciting STEM activities. Students and the public visit the project booths and interact with I-SWEEEP participants. HPS students engage visitors in hands-on STEM demonstrations, experiments, and robotics. We also

involve higher education institutions and corporations with STEM EXPO. For example, Texas A&M University presents the Chemistry Road Show that includes exciting chemistry experiments.

STEM Workshops for Teachers

To facilitate the spread of best practices in K-12 STEM education, HPS offers a large spectrum of professional development workshops for hundreds of science and math teachers who attend this public event. Harmony collaborates with STEM centers, regional service centers, higher education institutions, and technology corporations such as Texas Instruments, Vernier, and PASCO to facilitate these workshops.

STEM Symposium & Luncheon

This featured event brings business leaders, educators, legislators, and media leaders together to discuss the improvement of STEM education in our nation thorough a series of panel discussions. Additionally, they recognize and celebrate the success of educators who display exemplary performance to promote STEM education in the STEM Luncheon program.

More information on STEM education week can be found at www.stemtx.org.