HIGH SCHOOLS THAT WORK

SREB

Research Brief

The Next Step for Career/Technical Programs

Project Lead The Way and the Merging of Academic and Career/Technical Studies

The fact that too many students are losing interest in their education and dropping out of high school is not new information. With rising graduation requirements and declining student achievement, schools need to find new ways to engage students in learning and motivate them to graduate with the skills and knowledge they will need to be successful in the 21st-century work force. One key strategy for motivating students to succeed is to help them understand the connection between success in high school and success in careers and postsecondary studies — the connection between what they are asked to learn in class and what they want to accomplish in the real world. Programs that allow students to apply academic knowledge in the context of real-world career/technical (CT) studies — programs such as the Project Lead The Way® Pathway to Engineering high school curriculum — provide just such a connection.

July 2009

Project Lead The Way®

Since 1999, SREB has partnered with Project Lead The Way Inc. (PLTW Inc.) to prepare more high school students for further study and careers in engineering-related fields. PLTW Inc. is a not-for-profit organization that builds partnerships among public schools, postsecondary institutions and the business community and offers both a middle grades curriculum and a high school program of study.

The Project Lead The Way curriculum provides students with intellectually demanding, hands-on learning experiences that connect their engineering career interests to academic studies, particularly to rigorous mathematics and science courses. Schools adopting the Project Lead The Way curriculum are asked to enroll students into a sequence of college-preparatory mathematics and science courses and to meet key conditions:

- All teachers who will teach a Project Lead The Way course participate in an intensive, two-week summer training program for each course they instruct to better understand what academic and technical content to teach, how to engage students in learning and how to effectively assess students' progress.
- Counselors receive training to understand how the Project Lead The Way program can help students prepare for further education in engineering-related fields and the workplace and how to advise students on essential academic courses to take.
- Students complete a challenging sequence of mathematics and science courses.
- Students complete problem-based projects requiring the application of mathematics, science and technical knowledge.
- Students complete the common end-of-course examinations to assess whether they meet the Project Lead The Way course objectives.

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To determine the extent to which the Project Lead The Way curriculum provides students with effective school and classroom practices linking technical and academic learning, SREB compared Project Lead The Way students' results on the 2008 *HSTW* Assessment with the results of students in other pre-engineering programs and with the results of students in all career/technical programs.

This analysis of Project Lead The Way students addressed the following questions:

- Do Project Lead The Way students in the *HSTW* network achieve significantly higher scores on the *HSTW* Assessment reading, mathematics and science tests than students from similar career/technical fields and all career/technical fields?
- Are Project Lead The Way students more likely than other career/technical students to complete the *HSTW*-recommended curriculum?
- Do Project Lead The Way students who complete at least four years of college-preparatory mathematics and at least three years of college-preparatory science courses perform better than Project Lead The Way students who do not complete these courses?
- Do Project Lead The Way students have a richer set of learning experiences in their career/technical courses?
- Do Project Lead The Way students experience more challenging and engaging academic classroom instruction than other career/technical students?
- Are Project Lead The Way students more likely than other career/technical students to see a high school education as being important to their future?
- Are Project Lead The Way students more likely than other career/technical students to have a goal of pursuing postsecondary education?

Key Findings

- Significantly more Project Lead The Way students met the *HSTW* readiness goals on the 2008 *HSTW* Assessment reading, mathematics and science tests, compared with *HSTW* students in similar career/technical fields and *HSTW* students in all career/technical fields.
- Project Lead The Way students were significantly more likely than other career/technical students to complete at least four years of mathematics — including Algebra I, geometry, Algebra II and one higher-level math course — and at least three years of lab-based science courses during high school.
- Significantly more Project Lead The Way students experienced quality career/technical courses with embedded academic skills, compared with students in similar career/technical fields and students in all career/technical fields.
- Project Lead The Way students were significantly more likely to have experienced more engaging instructional practices in mathematics than other *HSTW* career/technical students.

Students classified as Project Lead The Way students for this study attended a *HSTW* site that used the Project Lead The Way curriculum and either completed at least three Project Lead The Way courses or were identified by their school as Project Lead The Way students. A total of 641 students were classified as Project Lead The Way students for this report.

To create the comparison groups for this study, SREB used a random sampling technique to generate demographically matched groups of students from similar programs[1] and from all career/technica (CT) programs. The demographics of Project Lead The Way students differed greatly from the demographics of all CT students. (See Table 1.) By matching the demographic composition of the two CT groups to the demographics of the Project Lead The Way group, SREB could more confidently attribute differences between the groups' achievement to students' school and classroom experiences, rather than their backgrounds.

Table 1: Project Lead The Way and *HSTW* Career/Technical Student Group Demographics

	All PLTW Students	All *HSTW* C/T Students (Unmatched)	Matched *HSTW* Comparison Groups (Similar CT Fields and All CT Fields)
Gender			
Male	80%	49%	80%
Female	20	51	20
Ethnicity			
White	69	60	69
Black/African-American	18	23	18
Other	13	17	13
Parental Education Level			
No Formal Education After High School	28	41	28
At Least Some Formal Education After High School	72	59	72

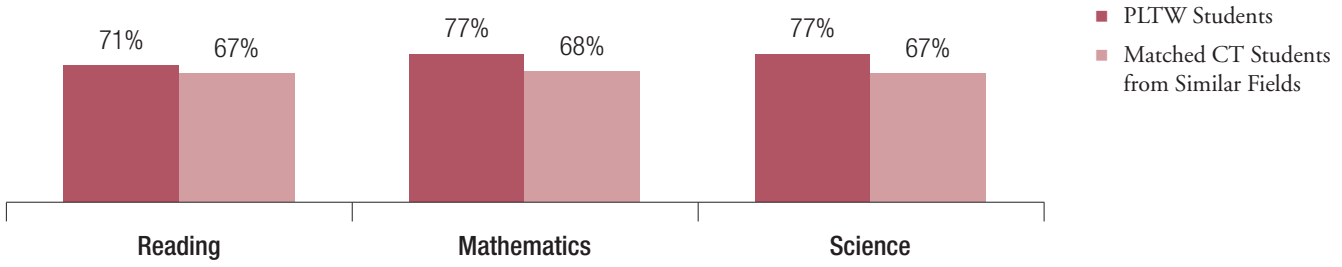
Source: 2008 *HSTW* Assessment
Note: Percentages are based on students who responded to the questions.

[1] Students from similar career/technical fields are students whose career/technical major is in Information Technology or Science, Technology, Engineering and Mathematics.

Do Project Lead The Way students in the *HSTW* network achieve significantly higher scores on the *HSTW* Assessment reading, mathematics and science tests than students from similar career/technical fields and all career/technical fields?

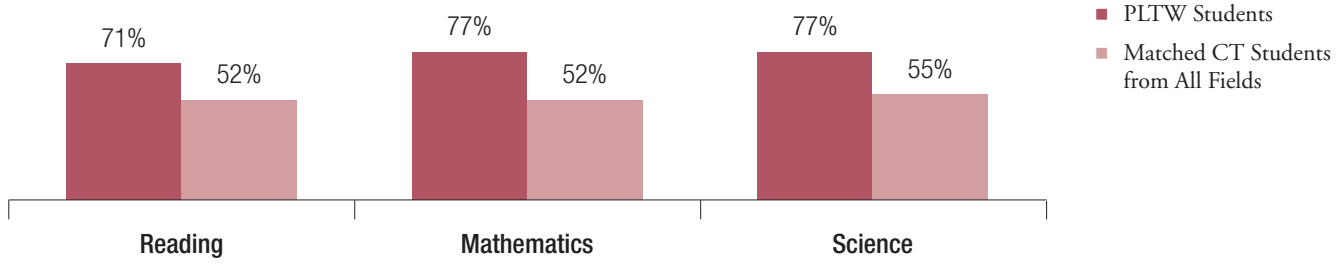
More Project Lead The Way students met the *HSTW* college- and career-readiness goals[2] in reading, mathematics and science on the 2008 *HSTW* Assessment, compared with CT students from similar fields. On both the math and science tests, at least nine more of every 100 Project Lead The Way students met the readiness goal than students in other CT programs. Project Lead The Way students outperformed students from all CT fields by an even wider margin, with 19, 25, and 22 more of every 100 student meeting the readiness goals on the reading, math and science tests, respectively. (See Figures 1 and 2.)

Figure 1: Students Meeting the *HSTW* Performance Goals: Project Lead The Way Students and CT Students from Similar Fields



Source: 2008 *HSTW* Assessment
Note: Differences between the percentages meeting the *HSTW* performance goals were significant at $p \leq .05$ on the chi-square test. *HSTW* performance goals in reading, mathematics and science are set at the level at which students are able to enter postsecondary studies without needing remediation.

Figure 2: Students Meeting the *HSTW* Performance Goals: Project Lead The Way Students and CT Students from All Fields



Source: 2008 *HSTW* Assessment
Note: Differences between the percent meeting the *HSTW* performance goals were significant at $p \leq .05$ on the chi-square test.

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[2] New subject tests were developed for the 2008 *HSTW* Assessment. *HSTW* started with the 2009 NAEP frameworks and modified them to suit *HSTW*'s college- and career-readiness goals. Panels of experts — including state superintendents, local superintendents, *HSTW* state coordinators, principals, teachers, career/technical educators and community college representatives — were convened to guide the development of and standard setting for these new tests. Readiness goals were set in each subject to indicate the level at which a student likely is able to pass employer exams for entry-level positions or enter postsecondary studies without needing remediation.

Are Project Lead The Way students more likely than other career/technical students to complete the *HSTW*-recommended curriculum?

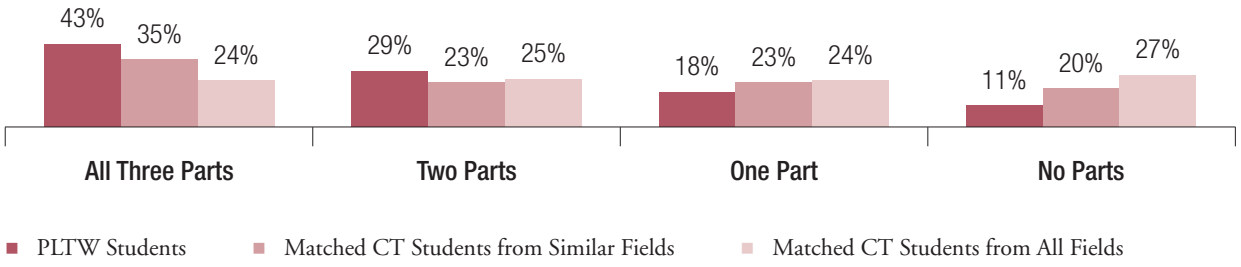
The differences in percentages of students meeting the *HSTW* readiness goals can be explained in part by the sequence of academic courses students completed and their experiences in both academic and career/technical classrooms during high school. The best predictor of student performance on the *HSTW* Assessment is the extent to which students completed the *HSTW*-recommended academic curriculum. Students who completed the recommended curriculum had significantly higher scores on all three sections of the *HSTW* Assessment than students who did not.[3]

Significantly more Project Lead The Way students completed the *HSTW*-recommended curriculum than other CT students from similar and all CT fields. (See Figure 3.) Forty-three percent of Project Lead The Way students completed all three parts of the curriculum (English, mathematics and science), compared with 35 percent of students from similar fields and 24 percent of students from all CT fields. Furthermore, only 11 percent of Project Lead The Way students did not complete at least one part of the *HSTW*-recommended curriculum, compared with 20 percent of students from similar fields and 27 percent of students from all career fields.

HSTW-Recommended Academic Curriculum

- **At least four college-preparatory English courses** that emphasize reading, writing and presentation skills.
- **At least four credits in mathematics**, including Algebra I, geometry, Algebra II and a fourth higher-level mathematics course.
- **At least three college-preparatory science courses**, including biology, chemistry, physics or applied physics, or anatomy/physiology.

Figure 3: *HSTW*-Recommended Curriculum Completed



Source: 2008 *HSTW* Assessment
Note: Differences are significant at $p \leq .05$ on the chi-square test.

These data indicate that the Project Lead The Way engineering program encourages more students to complete a challenging sequence of academic courses. This is especially true for the mathematics and science parts of the *HSTW*-recommended curriculum, which are particularly crucial for success in engineering-related postsecondary studies and careers. Compared with students enrolled in similar CT fields, 16 more of every 100 Project Lead The Way students completed at least four college-preparatory math courses (Algebra I and higher) than did CT students from similar fields, and 14 more completed at least three college-preparatory science courses. (See Figure 4.)

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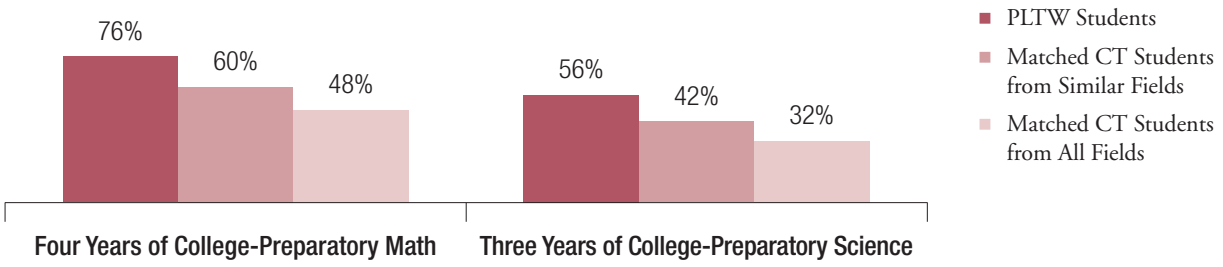
[3] Young, John and Fred Cline. *Validity of the* HSTW *Student Survey Indices for Predicting Assessment Scores*. Center for Validity Research, Educational Testing Service, 2007. Unpublished Work.

Figure 4: Course-Taking Patterns: Mathematics and Science



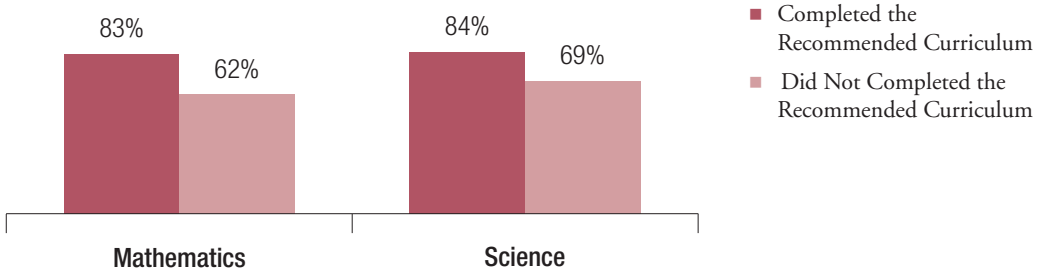
Source: 2008 *HSTW* Assessment
Note: Differences in students' course-taking patterns are significant at $p \leq .05$ on the chi-square test.

Well-designed programs of study developed around students' career interests can increase their propensity for taking a rigorous academic core curriculum by linking that curriculum to the contextual learning of career/technical courses. Such programs enable students to better understand the importance of challenging academics by demonstrating the connection between academic learning and students' educational and career goals.

Do Project Lead The Way students who complete at least four years of college-preparatory mathematics and at least three years of college-preparatory science courses perform better than Project Lead The Way students who do not complete these courses?

Significantly more Project Lead The Way students who completed four years of math and three years of science met the readiness goals in these subjects than students who did not complete these courses. Eighty-three percent of Project Lead The Way students who completed at least four credits of college-preparatory mathematics met the *HSTW* college- and career-readiness goal for mathematics, compared with 62 percent of Project Lead The Way students who did not complete the curriculum. (See Figure 5.) Of Project Lead The Way students who completed at least three years of college-preparatory/lab-based science classes, 84 percent met the *HSTW* college- and career-readiness goal for science, compared with 69 percent of those who did not complete at least three years of college-preparatory science. (See Figure 5.)

Figure 5: Project Lead The Way Students Meeting Readiness Goal



Source: 2008 *HSTW* Assessment
Note: Difference between the two groups is significant at $p \leq .05$ on the chi-square test. *HSTW* performance goal are set at the Basic proficiency level in mathematics and science.

Schools can ensure more students complete the recommended sequence of math and science courses by assisting students in planning career-focused programs of study based on their interests, talents and goals. More students will take challenging academic courses if they are enrolled in programs of study that connect academics to their interests and if their teachers and counselors explain why completing such courses is important to their future. Blending a sequence of mathematics and science courses with a planned series of Project Lead The Way courses enables students to understand the relationships between academic studies and their success in engineering-related courses.

Project Lead The Way students who complete four years of math and three years of science were more likely not only to meet the *HSTW* readiness goals (set at the Basic proficiency level), but also to achieve scores at the Proficient and Advanced levels. Nearly 50 percent of Project Lead The Way students who completed at least four years of college-preparatory mathematics scored at the Proficient level and above, compared with only 8 percent of students who did not complete such a sequence. (See Table 2.) More than 50 percent of Project Lead The Way students who completed at least three years of college-preparatory science courses scored at the Proficient level and above, compared with 28 percent of students who did not complete such a sequence. Students who meet the *HSTW* readiness goal are considered to be prepared for postsecondary studies without remediation, while students who achieve at the Proficient level or above are prepared for math- or science-intensive postsecondary programs, such as engineering studies.

Table 2: Project Lead The Way Students Scoring at Each *HSTW* Assessment Proficiency Level

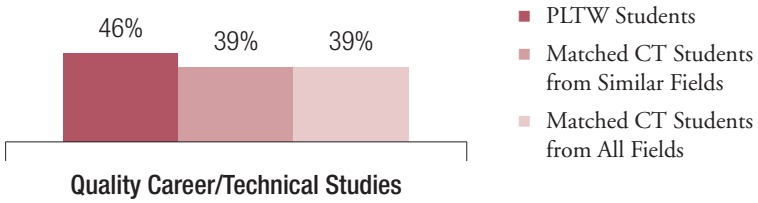
	Below Basic	Basic	Proficient / Advanced
Completed Four Years of CP Mathematics	17%	37%	46%
Did Not Complete Four Years of CP Mathematics	38	55	8
Completed Three Years of CP Science	16	31	52
Did Not Complete Three Years of CP Science	31	41	28

Source: 2008 *HSTW* Assessment
Note: Differences between groups are significant at $p \leq .05$ on the chi-square test.

Do Project Lead The Way students have a richer set of learning experiences in their career/technical courses?

Project Lead the Way courses are designed to provide opportunities for students to use their mathematics and science knowledge and skills to complete intellectually challenging, authentic projects. Project Lead The Way students were more likely than other *HSTW* CT students to complete assignments in their career/technical courses that required the application of skills learned in their academic courses. (See Table 3.) In addition, more Project Lead The Way students reported completing integrated projects under the direction of both their academic and career/technical teachers. Such experiences help students better understand the connection between academic learning and real-world problems.

Figure 6: Students Experiencing an Intensive Emphasis on Quality Career/Technical Studies



Source: 2008 *HSTW* Assessment
Note: Percentages are based on the number of students who answered the question. Differences between groups are significant at $p \leq .05$ on the chi-square test.

Table 3: Experiences from Career/Technical Classrooms

Students reported:	PLTW Students	Matched CT Students from Similar Fields	Matched CT Students from All Fields
They completed a challenging assignment in their CT classrooms **at least monthly**.	77%	76%	69%
They used mathematics to complete challenging assignments in their CT area **at least monthly**.	75	62	51
In their career/technical classes, they **sometimes** or **often** studied subjects related to what they had studied in their science classes.	63	52	51
They completed integrated projects under the direction of both an academic and a career/technical teacher that required mathematics **at least monthly**.	45	35	32
They completed integrated projects under the direction of both an academic and a career/technical teacher that required science **at least monthly**.	39	32	30

Source: 2008 *HSTW* Assessment
Note: Percentages are based on the number of students who answered the question. Differences between groups are significant at $p \leq .05$ on the chi-square test.

Do Project Lead The Way students experience more challenging and engaging academic classroom instruction than other students?

Literacy Across the Curriculum

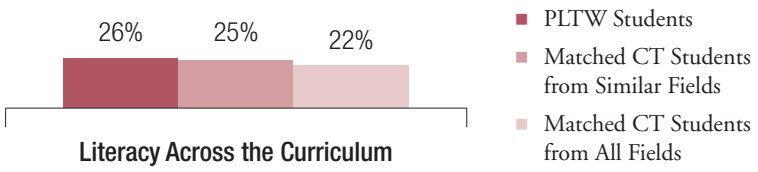
Achievement is influenced by the extent to which students are engaged in using academic knowledge and skills in all of their courses. Students who are engaged in reading and reflecting on a variety of academic and technical materials and in writing in all courses have higher reading, academic and technical achievement. When students have opportunities to analyze, synthesize and organize their thoughts and opinions frequently in writing and presentations, they are likely to increase their content-area achievement and their ability to comprehend difficult materials. Embedding reading and writing strategies into all courses increases student academic and technical achievement and prepares students as independent and lifelong learners.

HSTW Indicators for Emphasis on Literacy Across the Curriculum

Students reported:

- They used word-processing software to complete an assignment or project **often**.
- They revised their essays or other written work several times to improve their quality **often**.
- They were asked to write in-depth explanations about a class project or activity **sometimes** or **often**.
- They discussed or debated with other students about what they read in English or language arts classes **at least monthly**.
- They read an assigned book outside of English class and demonstrated that they understood the significance of the main ideas **at least monthly**.
- They read non-school-related materials outside of class for **two** or **more** hours in a typical week.
- They completed short writing assignments of one to three pages for which they received a grade in their English classes **at least monthly**.
- They completed short writing assignments of one to three pages for which they received a grade in their science classes **at least monthly**.
- They completed short writing assignments of one to three pages for which they received a grade in their social studies classes **at least monthly**.
- They read and interpreted technical books and manuals **at least monthly** to complete assignments in their career/technical area (CT students only).

Figure 7: Students Experiencing an Intensive Emphasis on Literacy Across the Curriculum



Source: 2008 *HSTW* Assessment

Figure 7 shows that not enough career/technical students — whether they are enrolled in Project Lead The Way or other CT programs — are intensively engaged in reading and writing strategies for learning in their academic and CT classrooms. The low percentage of Project Lead The Way students experiencing an intensive emphasis on literacy across the curriculum may provide some insight into their lower performance on the *HSTW* reading test, compared with their performance on the math and science tests. While Project Lead The Way students were engaged in using word-processing software and completing short writing assignments in their English classes, significantly fewer were required to read and interpret materials in their CT classes than were students in similar and all CT programs. (See Table 4.)

Table 4: Select Indicators for Literacy Across the Curriculum

Students reported:	PLTW Students	Matched CT Students from Similar Fields	Matched CT Students from All Fields
They used word-processing software to complete an assignment or project **often**.	65%	64%	52%
They completed short writing assignments of one to three pages for which they received a grade in their English classes **at least monthly**.	79	80	68
They read and interpreted technical books and manuals **at least monthly** to complete assignments in their career/technical area.	42	60	56

Source: 2008 *HSTW* Assessment
Note: Percentages are based on students who answered the question. Differences in the percentages between groups are significant at $p \leq .05$ on the chi-square test.

Numeracy Across the Curriculum

Students who have intensive, quality learning experiences with mathematics across the curriculum are more likely to understand the role of math in solving real-world problems. Such experiences include:

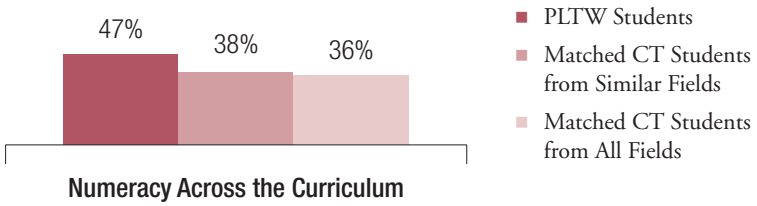
- taking four years of mathematics courses, including one during the senior year.
- using mathematics to solve real-world problems.
- working in collaborative teams with other students.
- making use of technology to advance mathematics achievement.
- using mathematics to complete assignments in career/technical classes.

HSTW Indicators for Emphasis on Numeracy Across the Curriculum

Students reported:

- They took a mathematics class during their senior year.
- They took at least four full-year mathematics courses in grades nine through 12.
- Their mathematics teachers **sometimes** or **often** showed them how mathematics concepts are used to solve problems in real-life situations.
- They used a graphing calculator to complete mathematics assignments **at least monthly**.
- They completed a mathematics project **at least monthly** that used mathematics in ways that most people would use mathematics in a work setting.
- They orally defended a process they used to solve a mathematics problem **at least monthly**.
- They worked with one or more students in their class **at least monthly** on a challenging mathematics assignment and received a group and individual grade.
- They worked in groups to brainstorm how to solve a mathematics problem **at least monthly**.
- They solved mathematics problems with more than one possible answer **at least monthly**.
- They solved mathematics problems other than those found in the textbook **at least monthly**.
- They used mathematics to complete challenging assignments in their career/technical area **at least monthly** (CT students only).

Figure 8: Students Experiencing an Intensive Emphasis on Numeracy Across the Curriculum



Source: 2008 *HSTW* Assessment
Note: Differences between groups are significant at $p \leq .05$ on the chi-square test.

More Project Lead The Way students experienced an emphasis on numeracy across the curriculum, including quality experiences such as having teachers show them how mathematics concepts are used to solve real-life problems. (See Table 5.) Higher percentages of Project Lead The Way students and students from similar CT fields had mathematics teachers who taught in ways that engaged students in challenging assignments — 65 percent of Project Lead The Way students said they used mathematics to complete a challenging assignment at least monthly, compared with 62 percent of students from similar fields and 49 percent of students from all CT fields.

Table 5: Select Indicators for Numeracy Across the Curriculum

Students reported:	PLTW Students	Matched CT Students from Similar Fields	Matched CT Students from All Fields
They took a mathematics class during their senior year.	87%	78%	71%
They took at least four full-year mathematics courses in grades nine through 12.	80	72	61
Their teachers or counselors **sometimes** or **often** encouraged them to take more challenging mathematics courses.	68	62	57
Their mathematics teachers **sometimes** or **often** showed them how mathematics concepts are used to solve problems in real-life situations.	80	78	71
They used a graphing calculator to complete mathematics assignments **at least monthly**.	91	86	76
They used mathematics to complete challenging assignments in their career/technical area **at least monthly**.	65	62	49

Source: 2008 *HSTW* Assessment
Note: Percentages are based on the number of students who answered the question. Differences between groups are significant at $p \leq .05$ on the chi-square test.

Engaging Science Curriculum and Instruction

Science achievement improves when students are encouraged to enroll in rigorous science courses and when science instruction involves students in:

- designing and conducting projects and activities.
- working in teams to complete challenging projects and activities.
- studying science using authentic, real-world problems.

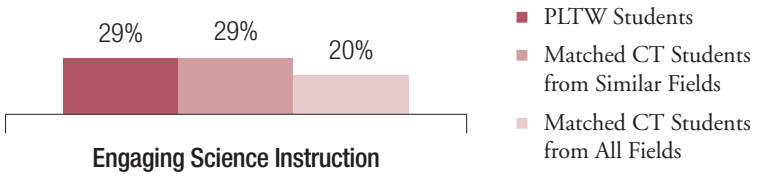
HSTW Indicators for Emphasis on Challenging and Engaging Science Curriculum and Instruction

Students reported:

- They completed any three of the following science courses: college-preparatory physical science, college-preparatory biology/Biology 2, anatomy, college-preparatory chemistry, physics or Advanced Placement science.
- Their science teachers **often** showed them how scientific concepts are used to solve problems in real-life situations.
- They took a science class during their senior year.
- They used science equipment to do science activities in a laboratory with tables and sinks **at least weekly**.
- They read an assigned book (other than a textbook) or article dealing with science **at least monthly**.
- They used science equipment to do science activities in a classroom **at least monthly**.
- They worked with one or more students in their class on a challenging science assignment **at least monthly**.
- They prepared a written report of lab results for laboratory investigations in science **at least monthly**.

The same percentage of Project Lead The Way students and students from similar CT fields — 29 percent — reported experiencing an intensive emphasis on engaging science instruction. (See Figure 9.)

Figure 9: Students Experiencing an Intensive Emphasis on Challenging and Engaging Science Curriculum and Instruction



Source: 2008 *HSTW* Assessment
Note: Differences in the percentages between groups are significant at $p \leq .05$ on the chi-square test.

Too few Project Lead The Way students and other career/technical students experienced an intensive emphasis on an engaging science curriculum. However, more Project Lead The Way students are experiencing some indicators of quality science curriculum and instruction than students in similar CT fields or all CT fields. (See Table 6.) More Project Lead The Way students completed career/technical assignments that related to what they studied in their science courses than other career/technical students; more Project Lead The Way students reported doing laboratory investigations in science and preparing a written report of the lab results at least monthly; and more Project Lead The Way students are completing at least three science courses. The number of science courses taken, reinforcement of science concepts in Project Lead The Way courses and investigative lab assignments likely contributed to Project Lead The Way students' higher science achievement on the *HSTW* Assessment.

Table 6: Experiences in Science and Career/Technical Classrooms

Students reported:	PLTW Students	Matched CT Students from Similar Fields	Matched CT Students from All Fields
They completed any three of the following science courses: CP physical science, CP biology/Biology 2, anatomy, CP chemistry, physics or AP science.	48%	34%	24%
They took a science course during their senior year.	76	65	57
They **sometimes** or **often** were encouraged by counselors or teachers to take more challenging science courses.	59	56	50
In their career/technical classes, they **sometimes** or **often** studied subjects related to what they had studied in their science classes.	63	52	51
They used science equipment to do science activities in a laboratory with tables and sinks.	36	39	33
They used science equipment to do science activities in a classroom **at least monthly**.	83	81	74
For laboratory investigations in science, they were required to prepare a written report of the lab results **at least once a month**.	66	61	56

Source: 2008 *HSTW* Assessment
Note: Percentages are based on the number of students who answered the question. Differences between groups are significant at $p \leq .05$ on the chi-square test.

Are Project Lead The Way students more likely than other career/technical students to see a high school education as being important to their future?

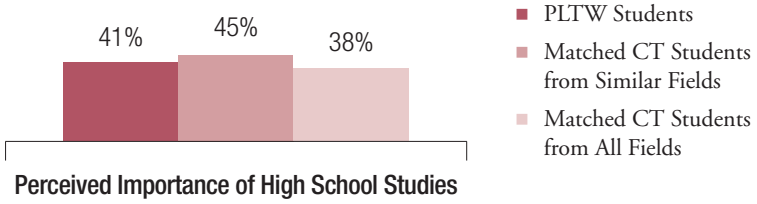
Fewer Project Lead The Way students perceived high school to be very important to their future than career/technical students from similar fields — 41 percent of Project Lead The Way students, compared with 45 percent of students from similar CT fields. (See Figure 10.) Furthermore, fewer Project Lead The Way students said they try to do their best work in class than did students in all CT fields. (See Table 7.)

HSTW Indicators for Emphasis on Perceived Importance of High School Studies

Students reported:

- Their courses **often** or **sometimes** were exciting and challenging.
- They **often** tried to do their best work in school.
- They **seldom** or **never** failed to complete or turn in their assignments.
- Most of their teachers often encouraged them to do well in school.
- Teachers **often** showed they cared about them by not letting them get by without doing the work.
- It is **very important** to study hard to get good grades.
- It is **very important** to participate actively in class.
- It is **very important** to attend all of their classes.
- It is **very important** to take a lot of college-preparatory classes.

Figure 10: Students Experiencing an Intensive Emphasis on Perceived Importance of High School Studies



Source: 2008 *HSTW* Assessment
Note: Differences in the percentages between groups are significant at $p \leq .05$ on the chi-square test.

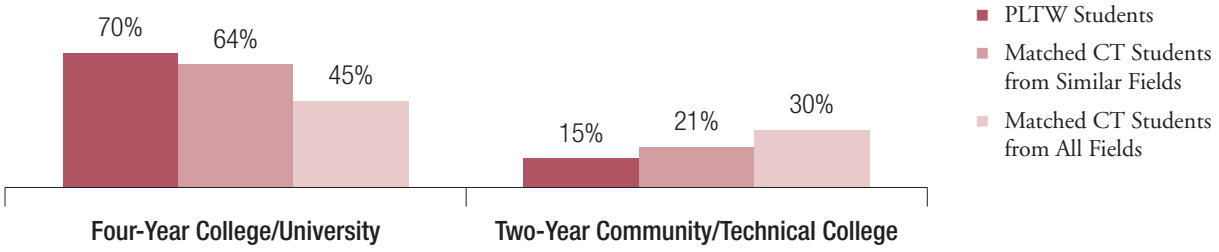
Table 7: Select Indicators for Perceived Importance of High School Studies

Students reported:	PLTW Students	Matched CT Students from Similar Fields	Matched CT Students from All Fields
They **often** tried to do their best work in school.	55%	63%	58%
They **seldom or never** failed to complete or turn in their assignments.	60	66	61
It is **very important** to attend all of their classes.	87	88	82
It is **very important** to take a lot of college-preparatory classes.	62	60	54

Source: 2008 *HSTW* Assessment
Note: Percentages are based on students who answered the question. Differences in the percentages between groups are significant at $p \leq .05$ on the chi-square test.

Project Lead The Way students are more likely to plan to attend a four-year college or university and less likely to plan to attend a two-year community or technical college than students in similar CT fields or all CT fields. Seventy percent of Project Lead The Way students said they planned to attend a four-year college or university after they graduated, compared with 64 percent of CT students from similar fields and 45 percent of CT students from all fields. (See Figure 11.)

Figure 11: Students Planning to Enroll in Postsecondary Studies



Source: 2008 *HSTW* Assessment
Note: Percentages are based on the number of students who answered the question. Differences between groups are significant at $p \leq .05$ on the chi-square test.

Implications for Improving Quality of Career/Technical Studies

The findings of this study indicate that, for the most part, Project Lead The Way students are experiencing higher-quality CT and academic studies than CT students in similar fields and all fields, resulting in higher academic achievement. The Project Lead The Way engineering curriculum has several characteristics that state and district policy-makers can consider applying to all career/technical programs to improve the quality of CT programs and the achievement of CT students.

- Establish high school guidance and advisement systems that help students better understand how career/technical studies can lead to a variety of postsecondary options — further training, an employer certification, an associate's degree, a bachelor's degree and employment. Train school counselors to become familiar with high-demand, high-skill, high-wage jobs in the area and with the preparation students will need (CT courses, college-preparatory academic courses, further training, postsecondary education, etc.) to enter these job markets.
- Invest in developing and adapting high-quality career/technical course designs and syllabi with accompanying instructional and curricular materials that require students to apply academic and technical knowledge to challenging, authentic projects.
- Provide intensive training to assist more career/technical teachers to:
  - teach newly-developed, high-quality CT courses, using the common course syllabi and support materials.
  - use project- and problem-based instructional strategies.
  - design assignments that require students to apply academic skills in the context of real-world problems.
  - develop intellectually demanding assignments that require students complete reflective, written analysis of readings and lab work.
  - design classroom examinations to assess academic and technical achievement.
- Create school organizational structures that provide opportunities for career/technical and academic teachers to plan common assignments that help students understand how academic and technical knowledge are related.
- Create low-stakes, end-of-course exams that teachers can use statewide to determine whether students have met the expected academic and technical achievement standards through their CT studies.
- Educate school leaders and counselors on how to organize programs of study that combine academic and technical studies and are driven by students' interests. These programs would result in more students completing a college-preparatory academic curriculum and sequence of at least four career/technical courses. Furthermore, such programs of study build upon students' interests to foster their motivation, rather than sorting them based on teachers' and leaders' perceptions of their abilities.
- Invest funds to modernize laboratories and acquire the necessary equipment and instructional supplies needed to provide high-quality career/technical programs that blend academic and technical content.

Implications for Improving the Project Lead The Way Engineering Program

While this study did reveal several positive characteristics of the Project Lead The Way curriculum, PLTW Inc. can improve the achievement of its students by taking the following actions:

- Continue to stress to teachers, counselors and school leaders the importance of requiring all Project Lead The Way students to complete four years of mathematics (Algebra I, geometry, Algebra II and higher) and three years of lab-based science courses. According to the findings of this study, if all Project Lead The Way students were to complete such a curriculum, the number of students meeting the college- and career-readiness goals would increase significantly.
- Train Project Lead The Way teachers to assist students in understanding how completing a solid sequence of English, mathematics and science courses can help them achieve their career and educational goals.
- Encourage all new Project Lead The Way teachers to communicate with their trainer and other experienced Project Lead The Way teachers after the initial summer training so they can quickly become acclimated to the curriculum.
- Train Project Lead The Way teachers to better utilize strategies that engage students in reading, interpreting and analyzing technical materials and writing technical reports. Devote time during the initial summer training to embedding reading skills (e.g., paraphrasing, summarizing) and reading and writing strategies for learning into student assignments.
- Continue to emphasize strategies for integrating academic content — reading, mathematics and science — into the curriculum and provide teachers with easy-to-follow steps for creating coordinated projects with academic teachers.
- Provide workshops through which Project Lead The Way teachers can work with English, mathematics and science teachers to plan and implement integrated projects that blend academic and technical concepts.
- Provide materials, workshops and online support to improve the rigor and quality of mathematics and science instruction at high schools participating in Project Lead The Way.
- Provide continuous training to counselors and school leaders on how to help students consider participating in the Project Lead The Way program at their school.
- Assist districts and schools interested in the Project Lead The Way program to locate grants from federal, state or local governments or from other sources so they can purchase the equipment needed to implement authentic, hands-on projects.

Methodology

Project Lead The Way students were drawn from the pool of students who participated in the 2008 *HSTW* Assessment. To be identified as Project Lead The Way students for this study, students had to have attended a high school with the Project Lead The Way program and either state that they completed at least three courses in the Project Lead The Way program or be identified by their schools as Project Lead The Way students. Using this sampling method, SREB was able to draw a sample of 641 Project Lead The Way students.

Preliminary analysis comparing Project Lead The Way students with *HSTW* career/technical (CT) students revealed substantial differences in the demographics of the two groups (Project Lead The Way students and all CT students). Thus, SREB used a random sampling technique to generate two CT groups — CT students from similar fields and CT students from all fields — that demographically matched the Project Lead The Way group. By matching the demographic composition of the two CT groups to the demographics of the Project Lead The Way group, SREB could more confidently attribute differences between the groups' achievement to students' school and classroom experiences, rather than their backgrounds.

The first step in creating these demographically matched CT groups was to create list of all *HSTW* career/technical students who attended high schools that did not have a Project Lead The Way program. This step ensured that the CT groups would not contain Project Lead The Way students. The next step was to randomly split the CT students into two pools to prevent any student from being drawn in both samples. This step eliminated the chance of a CT student could appear in both CT groups.

A stratified random sampling technique was used to draw demographically matched samples of *HSTW* CT students. This technique matched the groups of CT students to Project Lead The Way students by gender, ethnicity and parental education level. CT students from similar fields were drawn from students in the first pool whose CT major was in Information Technology or Science, Technology, Engineering and Mathematics. CT students from all fields were drawn from the second pool of students. The Assessment results of these three demographically matched groups — Project Lead The Way students, CT students from similar fields and CT students from all fields — were then analyzed.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