An Evaluation Report: i3 Development Grant Dev07 – Sammamish High School

"Re-imagining Career and College Readiness: STEM, Rigor, and Equity in a Comprehensive High School"

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Executive Summary

In 2009, Sammamish High School, a public comprehensive high school in the Bellevue School District, was struggling. Enrollment was declining. Since 2002, Sammamish High School has served an increasingly linguistically, socio-economically, racially, and ethnically diverse student body. Student achievement data revealed that gaps between groups of students remained a chronic problem despite efforts by various school leaders to significantly narrow them. Whereas gaps in reading and writing were narrowed, gaps continued in math and, to some extent, graduation rates. White students continued to outperform their African American and Hispanic peers. Middle class and affluent students continued to outperform their more impoverished peers. Students qualifying for Special Education and English Language Learner services and accommodations struggled to keep up with their mainstream, native English peers.

Instigated by a committee of teachers looking for a dramatic way to reset the school's academic culture, the school investigated various options for improving student outcomes. Problem-based learning (PBL) emerged as a promising approach. In 2010, Sammamish High School received a "Development"-level Investing in Innovation (i3) grant from the Department of Education. The school focused on science, technology, engineering, and mathematics (STEM) disciplines and identified PBL as their primary tool of school-wide improvement. In their grant proposal Sammamish articulated several goals and student learning and achievement outcomes they hoped to accomplish by 2015.

Their goals included:

- Implementation of PBL curriculum throughout the school to establish a scalable, sustainable, 21st century skills based program in Advanced Placement (AP) and non-AP coursework,
- Use PBL as a framework to support student growth in key cognitive strategies and academic behavior,
- Implement a series of specific supports for struggling students, focused on increased mathematics literacy,
- Provide customized and situated professional development (PD) that will help teachers implement new PBL curricula and evaluate their effectiveness to do so.

Their student learning and achievement outcomes included:

- 20% increase in AP pass rates, especially in STEM content areas (Biology, Chemistry, Statistics, Calculus AB/BC, Physics, Environmental Science),
- 20% increase in students with disabilities (SWD) and limited English proficient students (LEPS) enrolling in AP STEM classes,
- 75% of all students, 50% of SWDs, and 60% of LEPS successfully completing pre-calculus with a B or better,
- 100% of all students reaching standard on the state math test,
- 10% annual improvement on the state science test for all students,

- 15% annual improvement for SWDs and LEPs,
- 90% on-time graduation rate for SWDs and 75% on-time graduation for LEPS.

The purpose of this evaluation is to assess the extent to which Sammamish High School teachers and school leaders accomplished their goals. Because the school used PBL as the primary tool of school improvement, we focus specifically on the ways the school implemented PBL in coursework across the core content areas of Math, English, Science, and Social Studies, and the extent to which PBL may have contributed to school-wide differences in student learning and achievement. Throughout our evaluation process, we leveraged quantitative data stretching back over 10 years and qualitative data collected over the 5-year duration of the grant.

Problem-Based Learning (PBL) as the Driver for School Improvement

In their review of the research on problem- and project-based learning, Barron, et al. (1998) describe how problem based learning supports both skill and knowledge acquisition with deepening students' metacognitive skills. They state

> These principles mutually support one another toward two ends. One end is the acquisition of content and skills. The other end is to help students become aware of their learning activities so they may take on more responsibility and ownership of their learning. This awareness includes many aspects of what has been characterized under the umbrella term *metacognition*—knowing the goal of their learning, self-assessing how well they are doing with respect to that goal, understanding that revision is a natural component of achieving a learning goal, and recognizing the value of scaffolds, resources, and social structures that encourage and support revision (p. 273).

This and other educational research informed how Sammamish High School teachers and school leaders thought about the balance between the hard academic skills like reading, writing, and math, the soft 21st century skills of collaboration, critical thinking, and problem solving, and the metacognitive skills listed above that served as the foundation for how they articulated and acculturated those principles to achieve school-wide transformation through PBL.

Working over 4 years and in collaboration with researchers from the University of Washington, teachers and school leaders developed the Key Elements of Problem Based Learning to provide teachers with a highly articulated framework for understanding what PBL is and what it looks like in practice. While the school implemented multiple tools and policies to implement PBL throughout the school, the Key Elements served as the over-arching framework encompassing them all. Teachers working to redesign curriculum for various courses used the Key Elements framework to closely guide their curricular choices. Teachers and teacher leaders worked to develop and implement Sammamish Leads, a summer PBL enrichment program that matches groups of students with industry experts to solve authentic problems, and used the Key Elements to guide their design process. Teacher and school leaders working to design professional learning experiences to support the work teachers were doing in PBL curriculum redesign teams used the Key Elements to design teachers' professional learning in the summer and throughout the year.

Amidst competing definitions and descriptions of the difference between project- and problem-based learning and of what problem-based learning is and should look like, the Key Elements provided teachers and school leaders with a specific, common language for understanding what PBL is and how they could implement it in their classrooms. In sum, the Key Elements became the language Sammamish High School teachers and school leaders used to communicate their standards and expectations for what highly rigorous, immersive, and engaging student learning should look like.

The Key Elements of Problem Based Learning include:

- Authentic Problems
- Authentic Assessment
- Expertise
- Collaboration
- Academic Discourse
- Student Voice and Leadership
- Culturally Responsive Instruction

Taken together, the Key Elements provides teachers with a research-informed, practice-rich way to understand and implement PBL in their courses and classrooms. Readers of this report should be aware that for all intents and purposes, when we use the acronym "PBL" to describe the primary intervention Sammamish used to transform their school, we mean the Key Elements.

Measuring the Impact of PBL

The Department of Education awards three kinds of i3 grants: development, validation, and scale up. Sammamish High School received a "development" i3 grant. The purpose of the development grant was for schools to develop promising practices and policies other schools and educational organizations could learn from. The purpose of our evaluation is not to validate the school's choice of PBL as their primary intervention or to evaluate their success in seeding similar PBL interventions in other schools or districts. The purpose of our evaluation is two-fold. First, we identify and describe what the intervention was. We focus on PBL as the school's central intervention and also identify and describe several policies Sammamish High School leaders implemented to support teachers' implementation of PBL. Second, we measure how successful the intervention was in improving specific outcomes for students. In this Evaluation Report, we primarily focus on student performance outcomes demonstrated through quantitative findings.

To that end, we spend a majority of our evaluation describing the intervention, in this case PBL, and how it was implemented by Sammamish High School to improve student outcomes. We do this to evaluate the extent to which the school implemented their intervention with fidelity according to their evolving PBL framework and their initially stated goals. These include:

- The professional learning infrastructure the school designed to support teachers design and implementation of PBL curriculum,
- The process of PBL curriculum design as observed in teacher design teams,
- Supports the school created to improve students' career and college readiness,

- The development, adaptation, adoption of the Key Elements of Problem Based Learning which provided the framework for PBL design, implementation, and evaluation,
- The leadership structure the school used to support teachers' design and implementation of PBL curriculum.

To evaluate the effectiveness of the intervention, we share findings from a study in which we focus on student AP mean scores to compare two matched groups of students: those who took AP courses and the associated AP tests previous to the PBL intervention and those who took AP courses and the associated AP tests as teachers were implementing PBL across content areas.

Findings

Analysis of teacher surveys, teacher interviews, teacher focus groups, student focus groups, school leader interviews, classroom observations, and design team observations demonstrate that Sammamish High School developed and sustained effective structures for supporting teachers as they designed and implemented PBL across content areas. Specific findings suggest that

- Teachers found the professional learning experience of working in design teams and attending the summer Sammamish Institute of Teaching and Learning (SILT) relevant to their classroom practice and useful for helping them implement PBL principles and practices. Additionally, teachers highly valued their experiences collaborating with colleagues to redesign curriculum in PBL curriculum design teams.
- Many design teams successfully redesigned large portions of existing course curricula into PBL curricula during their design year.
- Throughout the duration of the i3 grant, students took the EPIC Campus Ready Assessment instrument at the end of each academic school year. Over time, students scored higher on the Key Cognitive Strategies portion of the survey, suggesting the school was successful in supporting an increase in students' career and college readiness.
- Teachers, teacher leaders, school leaders, and University of Washington educational researchers collaborated over four years to develop and refine the Key Elements of Problem Based Learning framework. Teachers used the Key Elements framework to redesign existing curriculum into PBL curriculum. Teacher leaders used the Key Elements framework to redesign all school-wide professional learning experiences. Over time, teachers and school leaders used the Key Elements framework to define and describe highly rigorous and engaging PBL curriculum and coursework.
- Teacher leaders were recruited from within the Sammamish High School teaching ranks to design all professional learning experiences and support teachers' work in PBL curriculum design teams and later in their efforts to implement PBL coursework. Teacher leaders and the principal constituted the school's Leadership Team. The Leadership Team was responsible for supporting and implementing nearly every aspect of the PBL i3 grant work.

Comparison of student Advanced Placement (AP) mean scores between matched groups of students who took AP courses and the associated AP test previous to the PBL intervention

(comparison group) and students who took AP courses and the associated AP test during the PBL implementation (treatment group) show gains in the treatment group's AP mean scores. We disaggregate these data according to course and academic departments. Specific findings show

- Students in the treatment group outperformed their matched peers in the comparison group on multiple AP tests. In some cases, student gains were statistically significant even when disaggregated according to students who receive free and reduced lunch (FRL), students with disabilities (SWD), and students who speak a first language other than English at home.
- Overall, students in the treatment group passed a higher percentage of their AP tests despite a dramatic increase in student enrollment in AP courses.
- Five years of CBAM survey data suggest not every academic department at Sammamish High School interacted with PBL in the same ways nor adopted PBL at the same level. The Social Studies and Science department fully adopted PBL as a guiding pedagogical framework. While they did not universally adopt PBL as a guiding pedagogical framework, teachers in the Math department continue to use the Key Elements to inform further curricula revisions. During the early years of the project the English department by and large determined that PBL was not a good fit as the instructional foundation for their courses. Thus, while some English courses were redesigned with PBL as their foundation, the overall stance of the English Department toward PBL is ambivalence.
- When aggregated to AP mean scores by academic department, students in the treatment group outperformed their comparison group peers in AP mean scores in AP coursework in the Math, Science, English, and Social Studies departments. In the Math, Science, and Social Studies departments, those gains were statistically significant.
- A strong, positive correlation exists between the number of PBL courses students take and their performance on AP tests.

Emerging Tensions

While these findings suggest gains in student learning and teacher growth achieved during a time of implementation of various PBL-focused policies implemented between 2010-2015, we observed several tensions within the school community that also seem to have emerged at that time. Interviews with school leaders suggest many of these tensions were both predictable yet unanticipated. Meaning, school leaders were cognizant that tensions inevitably surface whenever schools attempt to make wholesale changes to the way teachers teach and students learn. However, each school is different and the way those tensions manifest themselves within the school often times varies depending on the specific personalities of the students, teachers, and school leaders involved.

Tension 1: Balancing the Investment in Design and Implementation

The school invested heavily in teachers' PBL curriculum redesign process. However, little funds were invested in supporting teachers as they began implementing the PBL curriculum they planned in their design year. In a majority of teams, teachers found the implementation process to be just as time intensive and consuming as they worked to revise lessons and units in real time and

find time to regularly meet to share problems of practice to solve issues with the new curriculum. While some teams found ways to meet regularly and make the needed revisions, other teams and teachers struggled to meet the growing demands of teaching PBL curriculum.

Tension 2: The Influence of Departments and Department Leadership on Teacher Buy-In

Our data suggest that departments and department leadership provided a significant affordance and constraint to whether or not individual teachers adopted PBL as a pedagogical model. In some cases, department leaders supported teachers' ongoing PBL curriculum design and implementation work by doing such things as providing inter-departmental professional development during department "retreat" days and explicitly supporting ongoing course redesign and implementation. In other cases, department leaders hindered teachers' ongoing PBL curriculum design and implementation process by publicly expressing discontent or suspicion with PBL as a pedagogical model. In both cases, the power and influence department leaders brought to bear was crucial to the extent to which teachers felt supported continuing to implement PBL beyond the design year. In departments in which teachers had varied years of experience and varied expertise, which was most of them, the way departments supported or hindered the adoption of PBL impacted the extent to which novice teachers felt comfortable buying in to the PBL model.

Tension 3: Resentment Toward Teacher Leaders in Some Corners

Even though many teachers speak glowingly of the work the teacher leaders invested in supporting teachers' efforts to design and implement PBL curriculum, over time some teachers began to question various dimensions of the teacher leader role within the school. Some teachers voiced frustration that the teachers who were not teacher leaders had accumulated more expertise teaching PBL than the teacher leaders whose job it was to support them. Some teachers expressed resentment that the teacher leaders and leadership team accumulated outsized decision making power within the school and that there were few, if any, efforts made to broaden Leadership Team membership. They claimed that power was increasingly concentrated within the leadership team rendering other committees in the school, such as the Instructional Leadership Team (ILT), inconsequential and irrelevant. Still other teachers questioned how school leaders were holding the teacher leaders accountable and why the standards by which they were held accountable were not made more public and transparent to the staff.

The data suggest teacher leaders struggled with their new role as both teachers and teacher leaders and the ways in which the teacher leader role strained their relationships with some colleagues. Both the pace of their work and the urgency by which tasks needed to get done on a day-to-day basis made reflection by individual teacher leaders and the collective leadership team complicated and problematic. Although teacher leaders and the principal were aware of some teachers' concern described above, they may not have been aware of the extent and depth of growing resentment amongst some teachers on staff. For some teachers, tensions with the Leadership Team have conflated with other concerns possibly endangering the school's ability to sustain positive momentum toward PBL pedagogy and practice.

Tensions 1, 2, and 3 are most clearly evident in the qualitative data collected through teacher and school leader interviews and focus groups.

Chapter 1: The School Context

Sammamish High School serves students from various racial, ethnic, linguistic, cultural, and socio-economic backgrounds[1]. Specifically, it serves a significant English Language Learner (ELL) and Special Education (SPED) population. Approximately 1000 students attend the school: 45% of students qualify for free or reduced-price lunch, 10% qualify for ELL support services, 12% qualify for special education services and 47% will be in the first generation of college graduates for their family. Racially, 6% of students identify as African American, 20% as Asian, 20% Hispanic, 46% White, and 8% Multi-ethnic students.

When compared with most other high schools within the Bellevue School District, by just about any measure, Sammamish High School is more diverse. Only Interlake High School, which serves some of the same neighborhoods and students as Sammamish High School, has a similar demographic. For example, whereas approximately 45% of students at Sammamish High School receive free and reduced lunch, approximately 10% of students at Bellevue High School, approximately 10% of students at Newport High School, approximately 3% of students at International High School, and approximately 33% of students at Interlake High School receive free and reduced lunch[2].

Table 1 below demonstrates how Sammamish High School's free and reduced lunch population has dramatically increased since 2002.

Table 1.

Sammamish High School's Free and Reduced Lunch Population[3]	
Year	**Percentage**
2002	20%
2003	24%
2004	28%
2005	28%
2006	30%
2007	27%
2008	30%
2009	32%
2010	39%
2011	41%
2012	45%

[1] Data retrieved from the Washington State Office of the Superintendent of Public Instruction (OSPI) to reflect 2013 demographic data.

[2] Data retrieved from the Washington State Office of the Superintendent for Public Instruction on June 9th, 2015.

[3] Data represented in Table 1 provided by the Bellevue School District.

2013	46%
2014	41%

As research has repeatedly illustrated, a student's socioeconomic status, here represented by the percentage of students who receive free and reduced lunch, can be predictive of a students' performance on various high stakes tests (Darling Hammond, 2010; Berliner, 2013). Unlike other schools in the district, Sammamish High School leaders and teachers felt increased urgency to better support the growing number of impoverished students who attended the school and who experienced significant challenges in the classroom.

District Impact on Teacher-Centered Curriculum Design

Before the school began working on the i3 PBL project, much of the school improvement policies underway at Sammamish High School originated at the district level. In 1996, the school district hired a new superintendent who, over time, sought to improve district schools through the implementation of a common curriculum from kindergarten through 12th grade for every content area, and worked to open access to AP classes for all students. Both the common curriculum and AP open access policies relied heavily on curriculum as the driver of school improvement. Both policies were managed largely at the district level.

Knowledge of both policies is important to understand how and why Sammamish High School leaders and teachers approached implementation of PBL. First, the policy to open access to AP coursework to all students represented a fundamental shift in thinking for teachers for a couple of reasons. Many teachers were themselves students in AP classes that catered to a small population of students who had the support and resources to be successful in those classes. In many cases rigor was defined by massive amounts of reading and memorization to prepare students to be successful on the multiple choice and essay sections on the AP exam. By opening access to those classes to any students who wanted to take them, regardless of reading ability, motivation, or learning ability or disability, teachers worried that their pass rates would decline sharply. In some cases, teachers were right. Pass rates did decline at first. Teachers' frustrations were exacerbated when they received few additional resources to support the needs of the diversity of students who now took AP classes. Over time, however, AP pass rates stabilized and even increased as more students took more AP classes.

Second, the common curriculum was intended to support the open access AP class policy by scaffolding student learning in rigorous coursework from kindergarten through high school so students would be prepared to take and be successful in AP classes. The district's intention was to have teachers develop and design the common curriculum in grade level teams. Once developed, that curriculum would be posted online where teachers could access it and use it in their classrooms. From time to time teachers across the district would meet and discuss the effectiveness of the curriculum and design common assessments by which they could measure, across schools, the effectiveness of the new curriculum. The district's intention was that this process was to be democratic and collaborative and would increase the quality of student learning across the district by providing relevant and ongoing professional learning opportunities for teachers.

However, the common curriculum was not without problems. In some content areas, such as ELA and Math, once written, teachers felt as though they had little control to adapt and change the curriculum. In ELA and Math, the district curriculum was reinforced by mandated district assessments. In other content areas, such as Social Studies and to a lesser degree Science, the common curriculum existed but was not as highly articulated as it was in English and Math. Over time teachers in different content areas came to have vastly different experiences both with the "commonness" of the curriculum and the extent to which they controlled what they taught to their students.

The choices the school leaders made at Sammamish High School regarding curriculum redesign followed in the district's footsteps but took a different approach to implementation. The school asked teachers who had experience teaching a course to be part of the redesign effort. The school provided them with the Key Elements as a guiding document, but then got out of their way and gave them the time and space to redesign the curriculum with colleagues they knew and trusted. Either during the redesign year or in the year to follow, those same teachers piloted the curriculum they had redesigned and continued to work together to refine the plans they originally made. This often meant that teachers were teaching the same things, on the same days, in similar ways.

The historical legacy of the common curriculum and the varied way teachers experienced it across the district and at Sammamish High School did not evaporate because teachers' curriculum design work shifted. The school never intended to supplant the work teachers were already doing to align their curriculum with various national (Advanced Placement, Common Core, Next Generation Science Standards) and state standards (Essential Learning Requirements) and district expectations with PBL coursework. In those content areas where the curriculum infrastructure was especially robust, such as in Math and English, teachers were expected to design PBL curriculum in ways that aligned with Common Core State Standards and/or AP frameworks and existing district curriculum and assessments. For some teachers, that work was complex, complicated, and at times problematic.

Teachers and Teacher Attrition

The number of teachers teaching at Sammamish High School since 2010 has remained fairly consistent as illustrated by Table 2 below[4].

Table 2.

Teacher Population by Year	
Year	**Total Number of Staff**
2010-2011	83
2011-2012	70
2012-2013	81
2013-2014	76
2014-2015	75

[4] Data in Table 1 provided by data analysts at SEDL.

A vast majority of SHS teachers are "highly qualified." 79% of teachers hold a Masters degree or higher and 97% of teaches meet with ESEA definition of a "highly qualified" teacher. Although we are not privy to specific data, a large number of Sammamish High School teachers have earned their National Board Teaching Certificate (NBTC).

Why PBL?

PBL is not a new pedagogical idea (Dewey, 1938). Recent research has demonstrated that inquiry-, project-, and problem-based coursework has several benefits for student learning, including increasing student engagement and motivation (Blumenfeld et al., 1991; Barron and Darling-Hammond, 2008; Baoler and Staples, 2008; Belland, Glazewski and Ertmer, 2009; Conley, 2010). Although there is no guarantee that problem-based learning will completely close achievement gaps, various studies have shown that because the work is purposeful, interactive, and complex, students are more fully engaged in the learning than in more traditional learning environments (lecture-based, teacher-directed instruction) (Blumenfeld et al. 1991; National Research Council, 2000; Ravitz, 2009). This is especially true for students who historically have fallen within achievement gaps such as special education students, English language learners, and Hispanic and African American males. Recent research (Parker et al. 2011; Parker et al. 2013; Halvorsen et al. 2014) suggests that problem based learning deepens high school students' conceptual knowledge in Advanced Placement Social Studies and Science classes and can shrink achievement gaps between low and high SES elementary students in civics, economics, and citizenship coursework.

The basic tenets of problem-based learning include:

- Student-centered and generated learning,
- Struggle and collaboration around authentic and ill-defined problems,
- Extensive use of formative assessment and instructional coaching to scaffold student learning and skill proficiency,
- Innovation achieved through creative problem-solving,
- Making "the work" public through collaboration in teams to reach learning benchmarks, and
- Balanced theoretical content and real-world knowledge.

Barron and Darling Hammond (1998) argue that problem- and project-based learning offers challenges to teachers by demanding that they simultaneously develop curriculum, change and improve instruction, and develop richer assessment practices. In the schools where it works both teachers and students are engaged in problem-based learning and creative problem-solving to tackle difficult and persistent problems. Just as the learning looks fundamentally different for students, the work of teachers should look different.

Teachers have much to gain by enacting a problem-based model in their own work and learning endeavors. Just as student work is most effective when it is structured as inquiry around an ill-defined and authentic problem, teachers learn more when they collaborate with other teachers, especially when that learning centers on ill-defined problems evidenced by student work and artifacts from their classes (Ball and Cohen, 1999; Cochran-Smith and Lytle, 1999; Hargreaves and

Fullan, 2010). For teachers, some of the most powerful problem-based learning occurs in collaborative settings.

Strong teacher collaborative groups share certain characteristics. Teachers establish a shared commitment to the goals of the work and common norms to govern how they interact (Grossman, Wineburg, and Woolworth, 2001). They focus their efforts on solving relevant and authentic problems of practice (Cochran Smith and Lytle, 1999; McLaughlin and Talbert, 2006; Horn and Little, 2009). In addition, strong collaborative groups develop routines to efficiently complete tasks (Hammerness et al, 2005) and create a group culture that increases instructional capacity of teachers (Cochran Smith and Lytle, 1999; Hargreaves and Fullan, 2010). Barron and Darling-Hammond (1998) offer guidance on how teachers can focus their collaboration to find creative ways to support struggling students in a PBL context.

It should be noted, however, that the specific brand of PBL Sammamish teachers and school leaders established was anchored in the research literature but was specific to the students Sammamish serves. The Key Elements framework reflects a locally designed and developed PBL framework, informed by research and teachers' classroom practice.

Chapter 2: Fidelity of Implementation

This project focused a significant portion of its resources on redesigning the high school curriculum and an extant summer program using a Problem-Based Learning (PBL) model. To explore potential impacts of this effort the evaluation team engaged in 3 exploratory studies:

1. An Interrupted Time Series (ITS) research design which used historical and recent data (school years 2002-03 through 2014-15) to investigate whether changes in AP Test pass rates coincided with the implementation of the intervention (i.e., Problem-Based Learning),
2. A Pre/Post research design using matched treatment and comparison groups from school years 2005-06 through 2011-12 to explore relationships between exposure to PBL and student performance on AP Test scores, and
3. A Pre/Post Quasi-experimental research design (QED) using matched treatment and comparison groups to investigate the impacts of a revised summer program on college readiness as measured by the Campus Ready instrument.

In our evaluation report, we combine studies 1 and 2 into one exploratory study and present findings from study 3 separately.

Before discussing the methods and findings of these studies it is important to have a clear picture of the specific strategies that the project implemented so that a connection can be made between the project implementation and the outcome findings. A major role of the evaluation was to help project leadership define and refine this picture in terms of the project's critical components. Using PBL as their over-arching pedagogical vision, the school and evaluation team developed the Logic Model to provide the road map for what needed to happen and when and provides a larger context and rationale to understand the evaluation team's Exploratory Studies. Each component is necessary for the project to have fidelity to the model. Ideally, these components describe the project in enough detail and with sufficient criteria so that the "same" project could be implemented by other schools and districts and thus, could lead to similar outcome results. This evaluation task resulted in a revised logic model specific to the research foci listed above as well as a 'fidelity of implementation' rubric. This rubric describes each of the critical project components and a system for measuring the extent to which implementation was carried out in terms of desired quality and intensity.

Beginning with the original logic model and then analyzing qualitative and quantitative data collected by the evaluation team, seven components of the overall study emerged as critical for the fidelity of implementation model. These fell into two categories, Capacity-Building and PBL Implementation. Multiple indicators with criteria are used to evaluate the level of implementation fidelity for each component. The overall project fidelity of implementation components include:

<u>Capacity-Building</u>

Component 1: Increasing Teacher Pedagogical Expertise: Sammamish Institute for Learning and Teaching (SILT)

Component 2: Designing a Rigorous Curriculum: PBL Courses (redesign or new development) through PBL Design Teams

Component 3: Monitoring and Supporting Career Readiness: EPIC Campus Ready Survey, Application Support

Component 4: Development/Adaptation/Adoption of Research Based Framework for PBL Design, Implementation, and Evaluation

Component 5: Developing Distributed Expertise to Support a Rigorous Curriculum: Leadership Team

PBL Implementation

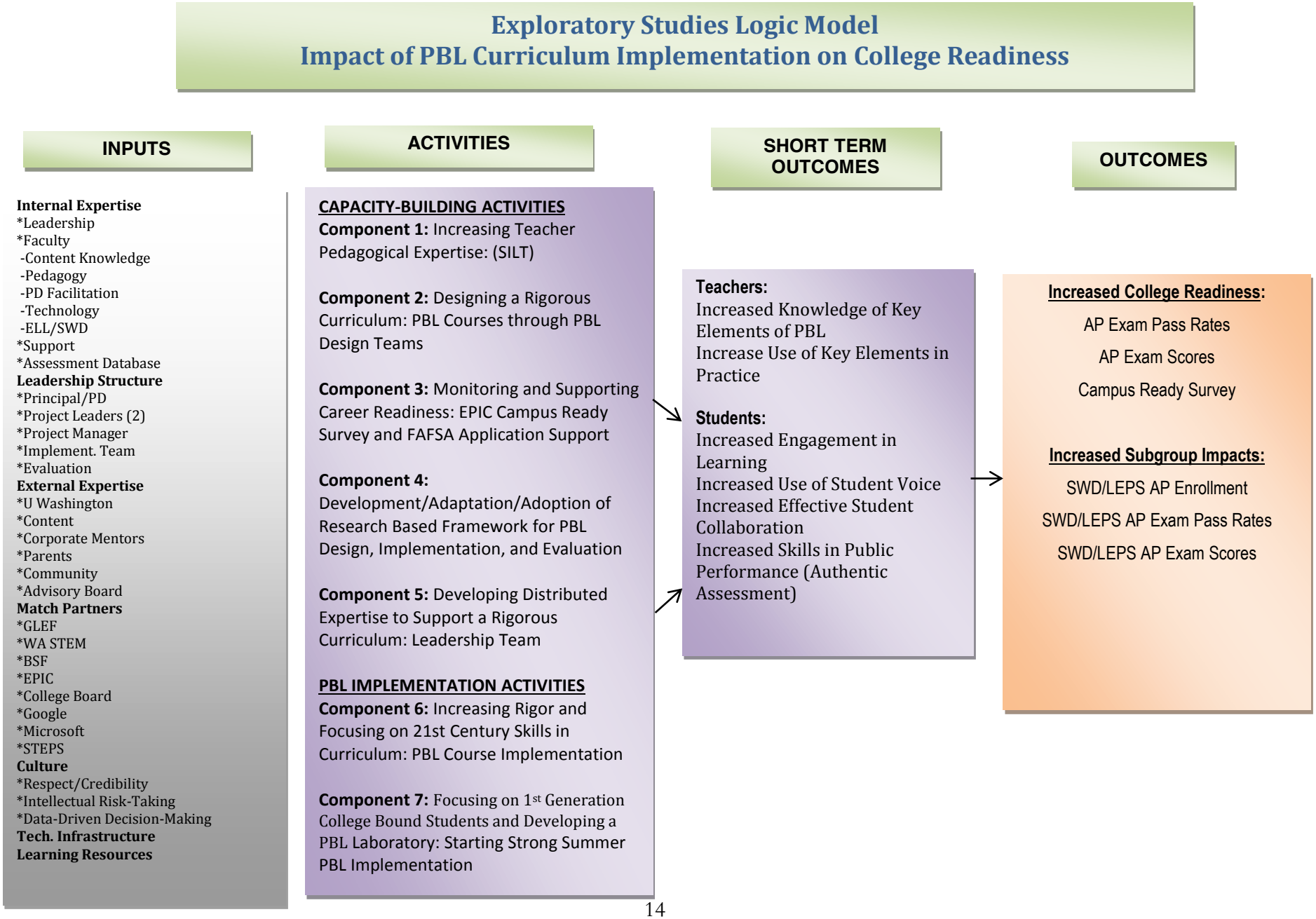
Component 6: Increasing Rigor and Focusing on 21st Century Skills in Curriculum: PBL Course Implementation

Component 7: Focusing on 1st Generation College Bound Students and Developing a PBL Laboratory: Starting Strong Summer PBL Implementation

The Exploratory Studies Logic Model below provides graphical representation of each of these components and the logic chain between them and the outcomes measured in the exploratory studies. In general the exploratory research questions were:

1. *Does student participation in the redesigned PBL curriculum lead to increased AP Test pass rates especially by students with disabilities (SWD) and limited English proficiency (LEPS) students?*
2. *Is student participation in the redesigned PBL curriculum associated with higher AP Test scores and with an independent measure of college readiness (i.e., Campus Ready)?*

Each component described below had a least one measurable indicator. In the following table each of the seven components and its corresponding indicators is designated by a numeral followed by a letter. The numeral refers to the component while the lower case letter refers to its corresponding indicator. For example, Component 1a is component "Increasing Teacher Pedagogical Expertise" and its first indicator "Quality of design."


Exploratory Studies Logic Model
Impact of PBL Curriculum Implementation on College Readiness
INPUTS
ACTIVITIES
SHORT TERM OUTCOMES
OUTCOMES
Internal Expertise
*Leadership
*Faculty
-Content Knowledge
-Pedagogy
-PD Facilitation
-Technology
-ELL/SWD
*Support
*Assessment Database
Leadership Structure
*Principal/PD
*Project Leaders (2)
*Project Manager
*Implement. Team
*Evaluation
External Expertise
*U Washington
*Content
*Corporate Mentors
*Parents
*Community
*Advisory Board
Match Partners
*GLEF
*WA STEM
*BSF
*EPIC
*College Board
*Google
*Microsoft
*STEPS
Culture
*Respect/Credibility
*Intellectual Risk-Taking
*Data-Driven Decision-Making
Tech. Infrastructure
Learning Resources
CAPACITY-BUILDING ACTIVITIES
Component 1: Increasing Teacher Pedagogical Expertise: (SILT)
Component 2: Designing a Rigorous Curriculum: PBL Courses through PBL Design Teams
Component 3: Monitoring and Supporting Career Readiness: EPIC Campus Ready Survey and FAFSA Application Support
Component 4: Development/Adaptation/Adoption of Research Based Framework for PBL Design, Implementation, and Evaluation
Component 5: Developing Distributed Expertise to Support a Rigorous Curriculum: Leadership Team
PBL IMPLEMENTATION ACTIVITIES
Component 6: Increasing Rigor and Focusing on 21st Century Skills in Curriculum: PBL Course Implementation
Component 7: Focusing on 1st Generation College Bound Students and Developing a PBL Laboratory: Starting Strong Summer PBL Implementation
Teachers:
Increased Knowledge of Key Elements of PBL
Increase Use of Key Elements in Practice
Students:
Increased Engagement in Learning
Increased Use of Student Voice
Increased Effective Student Collaboration
Increased Skills in Public Performance (Authentic Assessment)
Increased College Readiness:
AP Exam Pass Rates
AP Exam Scores
Campus Ready Survey
Increased Subgroup Impacts:
SWD/LEPS AP Enrollment
SWD/LEPS AP Exam Pass Rates
SWD/LEPS AP Exam Scores

Component 1: Increasing Teacher Pedagogical Expertise: Sammamish Institute for Learning and Teaching (SILT)

Indicators and Operational Definitions	**Data Collection**	**Fidelity Scale**	**Criterion**
1A. Quality of design: Percent of SILT institutes over 5 years that are designed in accordance with the SHS professional learning framework: (Framing, Choice, Application, Reflection)	Documentation	1: 0% to 20% meet PL criteria 2: 21% to 40% meet PL criteria 3: 41% to 60% meet PL criteria 4: 61% to 80% meet PL criteria 5: 81% to 100% meet PL criteria	Low=1,2 Med=3 High=4,5
1B. Quality of delivery: Internal Faculty Expertise Utilized Percent of faculty that design and/or lead sessions	SILT Design Documents	1: 0 % to 10% of faculty design and/or present 2: 11% to 20% of faculty design and/or present 3: 21% to 30% of faculty design and/or present 4: 31% to 40% of faculty design and/or present 5: 41% or more of faculty design and/or present	Low=1,2 Med=3 High=4,5
1C. Participant engagement 1: Faculty Attendance - the % of faculty that attend each year (Sum of attendance each day)/(num days*total faculty)	SILT Daily Rosters	1: 0% to 10% of faculty attend 2: 11% to 25% of faculty attend 3: 26% to 50% of faculty attend 4: 51% to 75% of faculty attend 5: 76% to 100% attend	Low=1,2 Med=3 High=4,5
1D. Participant engagement 2: Participant ratings Average overall SILT Rating across all years	SILT Participant survey	1: 0% to 20% rate SILT as relevant 2: 21% to 40% rate SILT as relevant 3: 41% to 60% rate SILT as relevant 4: 61% to 80% rate SILT as relevant 5: 81% to 100% rate SILT as relevant	Low=1,2 Med=3 High=4,5

Component 2: Designing a Rigorous Curriculum: PBL Courses through PBL Design Teams

Indicators and Operational Definitions	Data Collection	Fidelity Scale	Criterion
2A. Exposure: Total number of design team meetings offered (i.e., release time provided) per course team	PBL Meeting logs	1: 10 to 35 times per team 2: 36 to 70 times per team 3: 71 to 105 times per team 4: 106 to 140 times per team 5: 141 or more times per team	Low=1,2 Med=3 High=4,5
2B. Participation: Percent of teachers that participate on 1 or more design teams	Database	1:0 to 20% participate on Design Team 2:21 to 40% participate on Design Team 3:41 to 60% participate on Design Team 4:61 to 80% participate on Design Team 5:81 to 100% participate on Design Team	Low=1,2 Med=3 High=4,5
2C. Participant engagement: Participant ratings – Percent team members rating PBL Design Process as valuable to practice	PBL Team member interviews	1:0 to 20% rate Design Process as valuable 2:21 to 40% rate Design Process as valuable 3:41 to 60% rate Design Process as valuable 4:61 to 80% rate Design Process as valuable 5:81 to 100% rate Design Process as valuable	Low=1,2 Med=3 High=4,5

Component 3: Monitoring and Supporting Career Readiness: EPIC Campus Ready Survey, Application Support

Indicators and Operational Definitions	Data Collection	Fidelity Scale	Criterion
3A. College Readiness Monitoring: Campus Ready Assessment administered to all students	Survey Data	1: 0% to 50% response rate 2: 51% to 70% response rate 3: 71% to 80% response rate 4: 81% to 90% response rate 5: 91% to 100% response rate	Low=1,2 Med=3 High=4,5
3B. FAFSA Completion: Percent of seniors that fill out FAFSA	Documentation	1: 0% to 50% response rate 2: 51% to 70% response rate 3: 71% to 80% response rate 4: 81% to 90% response rate 5: 91% to 100% response rate	Low=1,2 Med=3 High=4,5
3C. Early AP: Percent of students that take AP Human Geography during their freshman.	Documentation	1: 0% to 50% of freshman take AP Hum Geo 2: 51% to 70% of freshman take AP Hum Geo 3: 71% to 80% of freshman take AP Hum Geo 4: 81% to 90% of freshman take AP Hum Geo 5: 91% to 100% freshman take AP Hum Geo	Low=1,2 Med=3 High=4,5

Component 4: Development/Adaptation/Adoption of Research Based Framework for PBL Design, Implementation, and Evaluation

Indicators and Operational Definitions	Data Collection	Fidelity Scale	Criterion
4A. Research-Based Framework: Adoption of a research-based model to guide project activities	Documentation	0: No framework is developed or adopted 5: Research-based PBL framework is developed and/or adopted	Low=1 High=5

Component 5: Developing Distributed Expertise to Support a Rigorous Curriculum: Leadership Team

Indicators and Operational Definitions	Data Collection	Fidelity Scale	Criterion
5A. Leadership Team Membership: Percent of core departments represented on Leadership Team (8 core departments) – five year analysis	Documentation	1: 0% to 19% of departments represented 2: 20% to 39% of departments represented 3: 40% to 59% of departments represented 4: 60% to 79% of departments represented 5: 80% to 100% of departments represented	Low=1,2 Med=3 High=4,5
5B. Leadership Team Roles: Team member roles specifically defined in terms of duties, responsibilities, and authority.	Documentation	1: Roles not explicitly defined 5: Roles explicitly defined	Low=1 High=5
5C. Meeting Frequency: Frequency of Leadership Team Meetings, five year analysis	Documentation	1: None or Yearly 2: Quarterly 3: Monthly 4: Weekly 5: Several times per week	Low=1,2 Med=3 High=4,5
5D. Design Team Support. The average number of yearly visits to each design team to provide support.	Interviews, Documentation	1: 0 to 1 visit 2: 2 visits 3: 3 to 4 visits 4: 5 to 6 visits 5: 7 or more visits	Low=1,2 Med=3 High=4,5
5E. Advisory Board: Frequency of yearly Advisory Board meetings	Documentation	1: 0 to 1 meetings 2: 2 meetings 3: 3 meetings 4: 4 meetings 5: More than 4 meetings (as needed)	Low=1,2 Med=3 High=4,5

Component 6: Increasing Rigor and Focusing on 21st Century Skills in Curriculum: PBL Course Implementation

Indicators and Operational Definitions	Data Collection	Fidelity Scale	Criterion
6A. Exposure to PBL: Percent of courses redesigned as PBL out of all courses	SHS Course Catalog PBL Classroom Observations	1: 0% to 20% of the slated courses implemented 2: 21% to 40% of the slated courses implemented 3: 41% to 60% of the slated courses implemented 4: 61% to 80% of the slated courses implemented 5: 81% to 100% of slated courses implemented	Low=1,2 Med=3 High=4,5
6B. Quality of PBL Delivery 1: Percent of courses that meet PBL Criteria (Sampled) [measured during project year 4]	PBL Observation Protocol Teacher Interviews	1: 0% to 20% of courses meet criteria 2: 21% to 40% of courses meet criteria 3: 41% to 60% of courses meet criteria 4: 61% to 80% of courses meet criteria 5: 81% to 100% of courses meet criteria	Low=1,2 Med=3 High=4,5
6C. Quality of PBL Delivery 2: Percent of courses that meet PBL Criteria as assessed by Leadership Team [measured during project year 5]	Leadership Team Assessment	1:0 to 20% of courses meet criteria 2: 21 to 40% of courses meet criteria 3: 41 to 60% of courses meet criteria 4: 61 to 80% of courses meet criteria 5: 81 to 100% of courses meet criteria	Low=1,2 Med=3 High=4,5
6D. Quality of PBL Delivery 3: Percent of courses that meet PBL Criteria as assessed by seniors [[measured during project years 4 and 5]	Senior Survey (years 4 and 5)	1: 0% to 20% of courses meet criteria 2: 21% to 40% of courses meet criteria 3: 41% to 60% of courses meet criteria 4: 61% to 80% of courses meet criteria 5: 81% to 100% of courses meet criteria	Low=1,2 Med=3 High=4,5
6E. Teacher PBL Adoption of PBL Innovation: Percent of design team teachers whose adoption curves match desired CBAM trajectory – five year analysis	Concerns Based Adoption Survey	1: 0% to 20% of teachers desired adoption curve 2: 21% to 40% of teachers desired adoption curve 3: 41% to 60% of teachers desired adoption curve 4: 61% to 80% of teachers desired adoption curve 5: 81% to 100% teachers desired adoption curve	Low=1,2 Med=3 High=4,5

Component 7: Focusing on 1st Generation College Bound Students and Developing a PBL Laboratory: Starting Strong
Sub-component 7A: Design of PBL Challenges and Workshops

Indicators and Operational Definitions	**Data Collection**	**Fidelity Scale**	**Criterion**
7A.1. Co-designed with External Partners: The design process transcends the boundaries of the school by engaging industry partners in the design of the PBL challenges. Definition: Each challenge involves at least 1 active external partner in the design process.	Interviews with director and analysis of design documents Frequent: the evaluator is present in some design meeting	1: 0% to 20% of challenges designed with external partner 2: 21% to 40% of challenges designed with external partner 3: 41% to 60% of challenges designed with external partner 4: 61% to 80% of challenges designed with external partner 5: 81% to 100% of challenges designed with external partner	Low=1,2 Med=3 High=4,5
7A.2 Authentic Challenges and Workshop Content: The content of Starting Strong is authentic to real contexts and related to college and career readiness	Student Survey Pre, mid, post	1: 0% to 20% of participants rate their challenge as authentic 2: 21% to 40% of participants rate their challenge as authentic 3: 41% to 60% of participants rate their challenge as authentic 4: 61% to 80% of participants rate their challenge as authentic 5: 81% to 100% of participants rate their challenge as authentic	Low=1,2 Med=3 High=4,5

Sub-component 7B: Implementation of PBL Challenges and Workshops

Indicators and Operational Definitions	Data Collection	Fidelity Scale	Criterion
7B.1. Co-Facilitated with External Partners: The implementation of the PBL challenges involves the external partner as a co-facilitator.	Observation during Starting Strong Each PBL challenge is observed for at least 30 minutes 3 times each during Starting Strong. Observers score each observation as a 0 (not facilitate) or 1 (co-facilitated with external partner)	1: 0% to 20% of challenges co-facilitated 2: 21% to 40% of challenges co-facilitated 3: 41% to 60% of challenges co-facilitated 4: 61% to 80% of challenges co-facilitated 5: 81% to 100% of challenges co-facilitated	Low=1,2 Med=3 High=4,5
7B.2. Attendance on Critical Days: Students must attend and participate for a minimum amount of time and days during the 'critical days. Critical days are defined as days 2 through 6 since that is where the bulk of the PBL intensive work occurs.	Attendance logs Collected daily	1: 0% to 20% of students attend days 2-6 2: 21% to 40% of students attend days 2-6 3: 41% to 60% of students attend days 2-6 4: 61% to 80% of students attend days 2-6 5: 81% to 100% of students attend days 2-6	Low=1,2 Med=3 High=4,5
7B.3. Active Student Participation & Collaboration: Percent of students that participate actively with their peers in collaborative groups.	Student Surveys Pre, mid, post Starting Strong	1: 0% to 20% collaborate effectively 2: 21% to 40% collaborate effectively 3: 41% to 60% collaborate effectively 4: 61% to 80% collaborate effectively 5: 81% to 100% collaborate effectively	Low=1,2 Med=3 High=4,5
7B.4. Authentic Assessment: Percent of students that demonstrate their knowledge, skills and understanding through public performance	Attendance logs	1: 0% to 20% of students present publically 2: 21% to 40% of students present publically 3: 41% to 60% of students present publically 4: 61% to 80% of students present publically 5: 81% to 100% students present publically	Low=1,2 Med=3 High=4,5

Scoring

Because this was a development project the criteria and thresholds for fidelity of implementation did not exist previously and thus were determined by the actual implementation data collected via interviews, surveys, observations, and document review. From these data the following thresholds were established for each component. Crossing these thresholds equates to fidelity of implementation.

Component	Threshold
1	Must have a score of high on at least three of the indicators AND no score of low on any indicator to meet fidelity at the School Level.
2	Must have a score of high on at least two of the indicators AND no score of low on any indicator to meet fidelity at the School Level.
3	Must have a score of high on at least two of the indicators AND no score of low on any indicator to meet fidelity at the School Level.
4	Must have a score of high to meet fidelity at the School Level.
5	Must have a score of high on at least three of the indicators AND no more than one score of low on any indicator to meet fidelity at the School Level.
6	Must have a score of high on at least three of the indicators AND no score of low on any indicator to meet fidelity at the School Level.
7A & 7B	Must have a score of high on at least three of the indicators AND no score of low on any indicator to meet fidelity at the School Level.

Analysis

On nearly every component evaluated, Sammamish High School implemented policies and tools to support PBL design and implementation to a high degree of fidelity.

	Component	Project Years	Threshold Criteria	Fidelity Score	Implemented with Fidelity?	Notes
1	Increasing Teacher Pedagogical Expertise: Sammamish Institute for Learning and Teaching (SILT)	1 - 5	High fidelity at the school level = at least 3 of 4 indicators have a score of high and no indicator has a score of low	Indicators: 4 Highs: 4 Meds: 0 Lows: 0	**Yes**	SILT and other professional development provide by project was a strength.
2	Designing a Rigorous Curriculum: PBL Courses through PBL Design Teams	1 - 5	High fidelity at the school level = at least 2 of 3 indicators have a score of high and no indicator has a score of low	Indicators: 3 Highs: 3 Meds: 0 Lows: 0	**Yes**	Teachers reported that time to design with colleagues was essential.
3	Monitoring and Supporting Career Readiness: EPIC Campus Ready Survey, Application Support	1 - 5	High fidelity at the school level = at least 2 of 3 indicators have a score of high and no indicator has a score of low	Indicators: 3 Highs: 2 Meds: 1 Lows: 0	**Yes**	Campus Ready administered consistently. Support for college application was not a visible part of project.
4	Development/Adaptation/Adoption of Research-Based Framework for PBL Design, Implementation and Evaluation	1 - 5	High fidelity at the school level = indicator must have a score of high	Indicators: 1 Highs: 1 Meds: 0 Lows: 0	**Yes**	Data suggests that the redesign of courses based on the conceptual framework was more important than implementing a specific instructional approach (PBL) that is consistent with the conceptual framework.
5	Developing Distributed Expertise to Support a Rigorous Curriculum: Leadership Team	1 - 5	High fidelity at the school level = at least 3 of 5 indicators have a score of high and no indicator has a score of low	Indicators: 5 Highs: 3 Meds: 2 Lows: 0	**Yes**	The leadership team was essential. Data suggests that clarity around the roles and membership of the leadership team, and intense support during course implementation would lead to better implementation.

	Component	Project Years	Threshold Criteria	Fidelity Score	Implemented with Fidelity?	Notes
6	Increasing Rigor and Focusing on 21st Century Skills in Curriculum: PBL Course Implementation	1 - 5	High fidelity at the school level = at least 3 of 5 indicators have a score of high and no indicator has a score of low	Indicators: 6 Highs: 3 Meds: 2 Lows: 0	**Yes**	Not all redesigned courses were implemented.
7	Focusing on 21st Generation College Bound Students and Developing a PBL Laboratory: Starting Strong	1	High fidelity at the school level = at least 3 of 6 indicators have a score of high and no indicator has a score of low	Indicators: 6 Highs: N/A Meds: N/A Lows: N/A	**N/A**	The revised Starting Strong summer program had not been 'PBL-revised' by the end of project year one.
7	Focusing on 21st Generation College Bound Students and Developing a PBL Laboratory: Starting Strong	2	High fidelity at the school level = at least 3 of 6 indicators have a score of high and no indicator has a score of low	Indicators: 6 Highs: 3 Meds: 0 Lows: 0	**Yes**	The redesigned summer program was initiated but full compatibility with PBL had not yet occurred.
7	Focusing on 21st Generation College Bound Students and Developing a PBL Laboratory: Starting Strong	3 - 5	High fidelity at the school level = at least 3 of 6 indicators have a score of high and no indicator has a score of low	Indicators: 6 Highs: 0 Meds: 0 Lows: 0	**Yes**	The redesigned summer program became an exemplary instantiation of Problem Based Learning (using the Key Elements conceptual framework as criteria.)

Chapter 3: Qualitative Methods

In our evaluation we use a mixed methods approach to triangulate the data to evaluate the impact the innovation (PBL) had on student learning outcomes. We use quantitative methods to compare student achievement outcomes for students from the 2004, 2005, 2006 cohorts with the students from the 2011 cohort. A student cohort is named for the year in which they started as freshman at Sammamish High School. For students to be included in a cohort sample, they must have completed all four years of high school at Sammamish High School among other variables we discuss in length below. We also use the Concerns-Based Adoption Model (CBAM) survey to measure teachers' concerns as they worked to adopt and implement the innovation (PBL) in their classes. Our qualitative measures include teacher interviews, focus groups, and classroom observations. Below we describe in detail how we collected, coded, analyzed, and validated the data to establish our findings.

Qualitative Measures

We use teacher interviews to evaluate how teachers were defining PBL over time and how they perceived its efficacy in their classroom practice. We also observed each redesigned course three times in the span of four months in 2013-2014 to determine the extent to which teachers were teaching PBL pedagogy in their day-to-day classroom practice. We describe our process for establishing protocols, collecting data, coding and analyzing the data, and validating our findings below.

Teacher interviews

Teachers, teacher leaders, and administrators were interviewed multiple times between 2010-2015. Teachers and teacher leaders were interviewed at various points from 2010-2014 to gain their perspective on the PBL curriculum design and implementation process was unfolding. Teacher leaders and the principle were also interviewed multiple times from December 2014-July and August 2015 to gain their perspective on their duties and responsibilities as school leaders throughout the life of the grant. In some cases there was overlap between the teachers who had been interviewed at various points since 2010 and the teachers who participated on the leadership and who were then interviewed 4 times between December 2014 and July/August 2015.

Teachers, teacher leaders, and the project manager (school principal) were interviewed between November 2013-January 2014. The research team interviewed teachers who had been funded members of a curriculum redesign team at any point between 2010-2013. We did not interview teachers who had participated on a design team but who had left the school. This sample included 36 teachers in the Math, Science, Social Studies, English, Physical Education, and Career and Technical Education departments. Interviews lasted between 30 minutes to 90 minutes depending on the teacher and their responses to the questions we asked.

A semi-structured interview protocol (cite here), adapted from the Levels of Use interview protocol (Hall, Dirksen, and George, 2006), was used for all interviews. The research team designed and field-tested the protocol with 2 teachers previous to use for formal data collection purposes. Three staff researchers conducted the interviews. Each interviewer was given the flexibility to adjust the interview as needed while making sure that each teacher was asked the same questions. We used a semi-structured protocol to provide the research team with specific questions designed to garner specific information from

teachers but that would flexible enough to allow teachers the space to respond to issues or topics that we may not have asked.

After the research team conducted all necessary interviews, each researcher transcribed the interviews they conducted. Interviews were transcribed using Microsoft Word and were uploaded to a Dropbox file. Two copies of interviews were saved. One anonymized (Excel file) and one with identifiable information attached (Word file). Another member of the research team, who did not conduct the interviews or have any knowledge of the school or project, transferred each interview into an Excel file and anonymized each interview by teacher but nested each file into department groups.

Analysis of each interview was conducted in two stages. Anonymized interviews were redistributed to researchers who then conducted initial open coding of one interview. The research team then met to review each open coded interview to surface patterns and themes that emerged and to conduct a more structured coding process of each interview. More than 40 codes emerged from this process. Codes were developed around the research questions used to drive the interview process. Questions include:

- What does PBL look like?
- How are teachers differentiating, if at all, between the Key Elements and PBL?
- Who is teaching PBL? To what extent?
- What do teachers think about it?

Based on the analysis performed by the research team, teachers were given numbers describing their level of understanding and use of PBL and the Key Elements according to the Level of Use (LOU) interview protocol. For example, a teacher who described their understanding and implementation of PBL in sophisticated and complex ways was given a 6 or 7 depending on the specifics of their interview. Teachers who described their understanding of PBL in simplistic ways and whose interview revealed little if any implementation of PBL pedagogy in their classroom received a 0 or 1 rating. Table 3, taken directly from Hall, Dirksen, and George (2006), illustrates the categories used to classify each teacher.

Table 3

Levels of Use (LOU)	
Scale Point	**Description**
Level 0: Nonuse	State in which the user has little or no knowledge of the innovation, has no involvement with the innovation, and is doing nothing toward becoming involved.
Level 1: Orientation	State in which the user has acquired or is acquiring information about the innovation and/or has explored or is exploring its value orientation and its demands upon the user and the user system.
Level 2: Preparation	State in which the user is preparing for first use of the innovation.
Level 3: Mechanical Use	State in which the user focuses most effort on the short-term, day-to-day use of the innovation with little time for reflection. Changes in use are made more to meet user needs than client needs. The user is primarily engaged in a stepwise attempt to master the tasks required to use the innovation, often resulting

	in disjointed and superficial use.
Level 4: Routine	Use of the innovation is stabilized. Few if any changes are being made in ongoing use. Little preparation or thought is being given to improving innovation use or its consequences.
Level 5: Refinement	State in which the user varies the use of the innovation to increase the impact on clients within immediate sphere of influence. Variations are based on knowledge of short and long-term consequences for clients.
Level 6: Integration	State in which the user is combining own efforts to use the innovation with the related activities of colleagues to achieve a collective impact on clients within their common sphere of influence.
Level 7: Renewal	State in which the user reevaluates the quality of use of the innovation, seeks major modifications or alternatives to the present innovation to achieve increased impacts on clients, examines new developments in the field, and explores new goals for self and the system.

After the research team rated each teacher, based on their interview responses, we grouped teachers by department and an average score was given for each department. Scores for departments ranged from 2-6.5. This score was in no way comprehensive and final of where we thought each department stood at that point in time. If anything, interviews revealed variability between teachers within departments, many times with scores for teachers within departments ranging between every LOU Level. However, the score developed for each department informed how we interpreted other data we had and were collecting at the time.

Classroom Observations

We conducted classroom observations concurrently with teacher interviews between December 2013-March 2014. We observed each teacher who was funded to participate on a design team, teaching a course they helped redesign. We conducted 3 observations of each teacher and negotiated with them to identify classes when they thought they would be teaching PBL curriculum. This process allowed us an opportunity to be efficient with our time and also triangulate our observations of what PBL pedagogy looks like in the classroom with teachers ideas about what PBL pedagogy looked like in practice.

We designed the protocol to align with the school's Key Elements of Problem-Based Learning. This document articulates the specific kind of PBL teachers designed into their courses and guided all of the course redesign work that occurred between 2010-2015. The protocol consisted of two parts. First, because PBL is largely a student-centered and focused pedagogy, we wanted to observe the amount of class time focused on direct instruction (teacher-centered) and the amount of time focused on student-centered independent and collaborative learning. In 3-minute increments, during classroom observations, researchers marked whether the instruction was teacher-centered or student-centered. Second, researchers observed how many of the Key Elements were present during the lesson and to what extent.

Before we conducted classroom observations, we field-tested the protocol with all the researchers who were responsible for conducting observations. During field-testing, we established a high level of inter-rater reliability, especially regarding the Key Elements section of the protocol. Each observer was asked to read and understand the Key Elements ahead of time. All three researchers spent an entire day conducting observations and debriefing observations after each observed class to establish a common vision of what each Key Element looks like in the classroom. We also established ways of observing the presence of such PBL components like an authentic problem and authentic assessment even if we had not observed them specifically in an observation. For example, students may be working toward solving an authentic problem but the task they may have been working on during one of our observations may not have been directly connected to the problem-solving task. As a team, we decided that even though solving the problem was not a specific task students were asked to work toward, because they were working within a context of a unit dedicated to an authentic problem, that our observations would count authentic problems as an observed component of that specific class.

After we our classroom observations, we considered two questions before we started coding and analyzing the data from the observations. First, what was the threshold we were going to use to define whether or not PBL was being implemented in any particular classroom? The Key Elements document articulates 7 different components of PBL pedagogy. However, not every element is equal to establishing a high level of PBL in a lesson. Second, how were we going to describe PBL implementation in a way that takes into account all the different ways teachers were attempting to implement PBL throughout the school?

We spent an entire day as a research team discussing what we had observed and describing what we thought "counted" as PBL teaching and learning. We concluded on the following hierarchy of elements to distinguish between teaching and learning that demonstrated PBL and teaching and learning that demonstrated PBL readiness but not full implementation.

- PBL Implementation is characterized by the presence of the following PBL elements:
    - Authentic Problems
    - Authentic Assessment
    - Culturally Relevant Instruction
- PBL Readiness is characterized by the presence of the following PBL elements but lacking in the presence of Authentic Problems, Authentic Assessment:
    - Culturally Responsive Instruction
    - Student Voice
    - Academic Discourse
    - Collaboration
    - Expertise

Our observations revealed that a teacher may be leveraging high levels of student collaboration and culturally responsive instruction in his/her instruction, but if those elements are detached from an authentic problem students are working on or an authentic assessment students will complete at the end of a unit, then that teacher's instruction demonstrates PBL readiness but not PBL implementation. Likewise, if a teacher anchors student learning in an authentic problem and will be assessing students' learning in an authentic way, then they are also likely asking students to work collaboratively and they have made efforts to make learning culturally relevant to students, for example. Based on our observations, for student

learning to count as problem-based learning, students must be engaged in authentic problems and must be assessed authentically, in ways that reflect how people are assessed when working within specific professions.

Classroom observations served as a key measure of PBL intensity. Once all classroom observation data was collected, data was uploaded into a master Excel file. Data from each classroom observation were converted into a rough percentage of time spent on teacher-centered instruction and student-centered time. As PBL is a heavily student-centered pedagogical model, this percentage provided us with a starting point for describing the extent to which any particular lesson had strong PBL elements to it. For a specific lesson to be considered a potential PBL lesson, student-centered activity would need to meet or surpass 75% of the observed class time. Table 4 below describes the threshold we used to differentiate between lessons that demonstrated PBL implementation and lessons that demonstrated PBL readiness.

Table 4.

Establishing the Threshold for PBL Implementation and PBL Readiness		
	PBL Readiness	PBL Implementation
Teacher-centered instruction	>25%	<25%
Student-centered activities	<75%	>75%
Key Elements observed	Culturally responsive instruction Expertise Collaboration Academic discourse Student voice	Authentic problems Authentic assessment Culturally relevant instruction *Expertise *Collaboration *Academic discourse *Student voice
(*) Designates key elements that may or may not have been present in PBL Implementation lessons. Classroom observations reveal than in many cases, lessons that demonstrated students explicitly working toward solving an authentic problem and an authentic assessment also demonstrated strong use of other key elements.		

Classroom observation data were analyzed using the above rubric to differentiate between lessons that exhibited PBL Readiness and lessons that exhibited PBL Implementation. In addition, we layered data from teacher interviews to identify courses that met the threshold of PBL Implementation. We grouped together teachers we observed who taught the same courses and combined the teacher interview and classroom observation data. Courses were deemed PBL Exemplars if 1) the lessons teachers taught met the criteria for PBL Implementation and 2) who scored highly (5-7) on our teacher interview ranking scale. At the time, those courses included AP Human Geography, AP United States Government, BioChem, Marketing, and AP Chemistry.

Chapter 4: Increasing Teacher Pedagogical Expertise

In order to implement PBL across content-areas, school leaders deployed innovative approaches to building capacity in their teaching staff through a robust infrastructure of professional development. Believing that best curriculum is that which is designed by existing staff to serve the specific needs of their students, the school made large investments in professional learning designed to build capacity in teachers so that they could design engaging PBL coursework. At the time of the grant, a vast majority of the teachers had little knowledge, expertise, or experience with PBL. School leaders supported teachers' professional growth by 1) providing them the paid time and space to design PBL curriculum in design teams; 2) developing SILT, the teacher-led and designed summer professional learning experience; and 3) providing teachers further support to implement PBL in teacher-led and designed monthly staff meetings. Most importantly, each component of the professional learning infrastructure relied heavily on teachers' evolving PBL expertise to provide relevant and authentic professional development.

Sammamish Institute of Learning and Teaching (SILT). The collaborative culture developing within design teams bled into how teacher leaders approached how they designed SILT. Starting the Spring before, teacher leaders identified teachers whose expertise matched well with what the theme of the next summer's SILT would be. For example, if part of the next year's SILT would be dedicated to authentic assessment, teacher leaders recruited teachers within the school who were experimenting with standards-based grading or assessing collaborative groups and asked them to design sessions for the upcoming SILT. Teacher leaders would set the agenda but teachers would design and lead the sessions. During one year of SILT, teacher leaders designed SILT like a conference, providing teachers with choices of sessions they could attend throughout the day. These two principles, teacher-designed and led sessions and teacher choice, established a culture of teacher professionalism and deepened teachers' pedagogical expertise. Teachers began to view their colleagues as their first and most important resource to improve their instructional practice.

Monthly Staff Meetings. Although not new to the project, school leaders repurposed monthly staff meetings to support teachers' ongoing PBL design and implementation process within the school. Instead of the principal standing in front of the staff issuing dictates, teachers led their colleagues in thoughtfully designed professional learning focused on some aspect of PBL design or implementation, usually aligned with the focus of that year's SILT workshop. Staff meetings afforded teachers the time and space to collaborate across content-areas on universal problems of practice, such as how to support ELLs as they struggled to work in collaborative groups within PBL focused units. Like the SILT workshops, staff meetings provided teachers with "just in time" professional learning opportunities where they could learn from their colleagues' successes and struggles.

PBL Curriculum Design Teams. To redesign traditional curriculum into PBL curriculum, school leaders established PBL curriculum design teams. Design teams, as they were referred to, consisted of a group of 3-5 teachers who had experience teaching the course they were redesigning. Membership was diverse and voluntary and was not constrained by seniority, years of teaching experience, or perceived expertise. Once on a design team, teachers were provided with a daily, common, planning period to meet to redesign an established course into a PBL course.

School leaders designed and established a professional development infrastructure that supports professional growth and learning around problem based learning (PBL) pedagogy and principles. Each teacher may be on a different professional growth trajectory focused on various instructional practices, beliefs, and values, but the school expects that teachers immerse themselves in a process of collaborative instructional improvement and that they keep moving forward in that process throughout the year. The school developed three different, formal spaces where teachers could engage in professional development and growth: the Sammamish Institute for Teaching and Learning (SILT), monthly staff meetings, and PBL Design Teams. (Curricular design teams are described below as Component 2. These activities served both as a source of professional learning and as the process through which courses were redesigned.) We summarize each space briefly below and then describe each more in detail later in the chapter.

Table 5 summarizes the way each professional learning context contributes to teachers' professional growth.

Table 5.

Sammamish High School Professional Learning Infrastructure			
	SILT	**Staff meeting**	**Design teams**
Purpose	Teachers build a common language about "the work"/PBL principles and pedagogy using the Key Elements as a focus. To disrupt "traditional" ways of thinking about students and student learning.	Refine, revisit, further learning/knowledge experienced in SILT. Work with different groups throughout the year—design teams, department groups, interdisciplinary groups.	Integration of PBL theory and collective practice in collaboration with other teachers. Examination of one's practice in a collaborative setting in the process of innovation and experimentation. Sustained collaboration to engage in cyclical process of reflection and inquiry.
Process	Choice Interdisciplinary team plans it and represents a variety of perspectives in the building Leverages expertise of partners, students, research literature Teacher led Knowledge processed collaboratively Focus on problems and practices that are authentic to teacher's individual practice	Choice when appropriate Highly structured and organized around focal Key Element Teacher led with multiple teachers leading over the course of the year Planned by teacher leadership team Leverages collaborative and cooperative learning strategies	Shared task for a specific course they are teaching Given resources/tools Freedom to structure their own learning and collaborative practice Collaborative with other teachers who draw from various expertise and experiences in the classroom Results from teachers working through different opinions, values, beliefs about pedagogy and practice

			Application of principles reified in the Key Elements to teachers' collective and individual practice

Summer Institute of Learning and Teaching (SILT)

Among other things, the funding received from the i3 grant facilitated an expansion and overhaul of how the school administered professional development and learning. Prior to receiving the grant, teachers participated in monthly staff meetings and two days of required professional development during the summer. In order to support teachers as they increased their knowledge and facility with PBL pedagogy, the school developed or adapted three components of professional learning: the summer institute of learning and teaching (SILT), PBL Design Teams, and monthly staff meetings. With few exceptions, teachers designed, developed, and led each component of their own professional learning.

The school facilitated the SILT professional development days starting in August 2011 and continued through the 2014 school year. Designed by teachers and teacher leaders, SILT was a formal professional development experience. The school offered SILT during the last week of August, prior to the beginning of the school year. Although attendance was voluntary, the school paid teachers for their time if they attended. The topic for SILT varied but was largely aligned with further learning on specific Key Elements.

The school tacked closely to three design principles as they worked to plan and implement SILT from year to year. First, teachers designed and led the sessions having to do with the essential learning each SILT was designed around. For example, in 2011, teachers designed and led all the sessions having to do with student collaboration and literacy. Second, in most cases, teachers could choose which sessions to attend for at least part of each SILT day. Third, at the end of most SILT days, teacher session leaders, teacher leaders, administrators, and partners assembled to examine teacher survey data from that day's SILT sessions. These discussions informed the group's decision making from day to day and year to year.

Each day generally proceeded as follows. Teachers would arrive and teacher leaders would debrief the staff on the agenda for the day. Teachers would choose sessions to attend until lunch. After lunch, teachers would meet with either their design teams or an inter-disciplinary professional learning community. Before each day was brought to a close, teachers took a survey rating the effectiveness and relevance of each component of the day's schedule. After teachers took the survey, a group of teachers, teacher leaders, administrators, and representatives from partner organizations would assemble and unpack the survey data to discuss teachers' perceptions of that day's learning.

Methodology

The data from SILT comes from online surveys administered through the Survey Monkey platform. At the end of every SILT professional development day teachers took an online survey asking them to rate the effectiveness and relevance of the day overall and to rate the specific sessions they attended throughout the day. Rating questions were designed using a Likert scale. Table 6 below is an example of the Likert Scale we used to receive feedback from teachers.

Table 6.

Measuring Relevance at SILT				
Session	**How relevant were the following components of the morning session of today's SILT?**			
Defining challenge	Not relevant	Somewhat relevant	Extremely relevant	Did not attend
Developing an action matrix on assessment	Not relevant	Somewhat relevant	Extremely relevant	Did not attend

Questions asking teachers the extent to which they found SILT sessions relevant to their practice remained largely unchanged from year to year to ensure internal reliability for each question and the ability to compare teacher responses from year to year. In addition, teachers answered open-ended questions that asked them to extrapolate on their ratings of each session and the day overall. Each survey also contained questions that asked teachers to describe what they had learned from each session and the day overall.

These surveys served two important functions. First, by looking at the number of responses to each survey, we can approximate the number of teachers who attended each SILT day. Although this is not an exact number, because for whatever reasons specific teachers may not have completed a survey, overall we are confident a vast majority of teachers who attended each SILT day also completed a survey for each day. Second, the surveys provide us a way to measure the extent to which teachers perceived SILT as a valuable learning tool that helped them improve their practice.

Research questions

In this section, we address the following questions regarding the professional development the school developed to support teachers' learning.

- To what extent did teachers participate in SILT?
- To what extent did teachers find their professional development in SILT to be authentic and relevant to their practice?
- To what extent did teachers learn from their professional development experiences in SILT?

Findings summary

- SILT was implemented to high degree of fidelity as defined by the logic model produced by the school and the evaluation team. Especially strong factors that contributed to a high degree of fidelity include:
    - Using teachers to design and lead sessions,
    - Designing each SILT day allowing for teachers to choose which sessions they attended at various times throughout the day, and
    - High participation rate amongst teachers from day-to-day and year-to-year.
- A majority of teachers on staff at the beginning of each year participated in SILT.
    - Teacher exposure to PBL pedagogy and principles was high.
- Teachers perceived the SILT professional development experience positively with the majority of respondents stating that the learning was both relevant and useful to their practice.
- Specifically, teachers pointed to several features of the SILT experience as especially powerful in terms of their own learning including:

- Learning focused on topics and themes teachers perceived as relevant to their practice,
- Teacher-developed and led sessions,
- The ability to choose particular sessions of interest, and
- Adjusted agendas and learning objectives based on survey feedback from teachers.

Findings

In the following section, we present our findings in two ways. First, we present data to evidence the extent to which SILT rates highly according to our fidelity measures. These measures include an analysis of 1) teacher exposure to SILT, 2) SILT quality, 3) teacher engagement in SILT according to teacher attendance, and 4) teacher engagement in SILT according to how teachers rated the effectiveness of each SILT experience. Second, we use our data to more fully answer the research questions stated above having to do with relevant, authenticity, and practicality of SILT sessions.

Fidelity measures

Our data show SILT was implemented according to a high degree of fidelity in the first three years of the grant. As the school refined its approach to how it designed and implemented SILT from year to year, some measurements, such as exposure, were harder to measure. For example, in the third year of SILT, teachers were paid to meet for 8 hours over the summer to work on problems of practice of their choice. Survey data show many teachers participated in this component of SILT, but because their participation was self-reported, it is difficult to say with any certainty just how many actually did. However, those teachers that did participate rated highly that specific component of SILT.

SILT exposure

As illustrated in Table 7 below, our data show that participating teachers who attended every day of SILT during a given year had high exposure to learning focused on PBL pedagogy and principles.

Table 7.

Teacher Participation in SILT		
Year	**Exposure as measured in hours**	**Teacher participation as measured by the average number of teachers who completed daily surveys for each SILT year**
2011	48 hours (6 days, 8 hours a day)	52
2012	40 hours (5 days, 8 hours a day)	49
2013	24 hours (3 days, 8 hours a day)	44
2014	24 hours (3 days, 8 hours a day)	32

Based on the data present in the table above, Table 8 below shows the overall fidelity rating SILT receives based on a measurement of exposure.

Table 8.

Fidelity Rating: SILT				
Component	**Operational definition**	**Data collection**	**Fidelity scale**	**Criterion for adequate/high fidelity of implementation**
SILT exposure	Exposure: Total Duration – the total number of	SILT design documents SILT observations	1: 0 to 10 hours per SILT 2: 11 to 20 hours per SILT	Low = 1, 2 Med = 3

	hours of training offered		3: 21 to 30 hours per SILT 4: 31 to 40 hours per SILT **5: 41 to 50 hours per SILT**	**High = 4, 5**

Question 1: To what extent did teachers participate in SILT?

Teachers were surveyed at the end of each SILT experience. Some years, such as in 2011 and 2012, the school surveyed teachers at the end of each SILT day to gauge how relevant the specific learning for that day was for their daily practice and to inform tweaks and revisions the leadership team would make for the next day's SILT focus. In other years, such as in 2013 and 2104, the school surveyed teachers periodically during SILT and then at the end of the professional development experience as a whole. Although not a perfect measure of teacher engagement in SILT, we use surveys as a measure of teacher participation. Table 9 shows the extent of teacher's participation in SILT from 2011 to 2014.

Table 9.

SILT Data Collection Summary		
SILT Session	**Number of respondents**	**Number of possible respondents**
SILT 2011, Day 1	57	70
SILT 2011, Day 2	56	70
SILT 2011, Day 3	51	70
SILT 2011, Day 4	49	70
SILT 2011, Day 5	51	70
SILT 2011, Day 6	50	70
SILT 11-16-11 Feedback	66	70
SILT 2012, Day 1	54	81
SILT 2012, Day 2	50	81
SILT 2012, Day 3	45	81
SILT 2012, Day 4	44	81
SILT 2012, Day 5	53	81
SILT Year 3 Survey	50	76
SILT 2013, Day 1	41	76
SILT 2013, Day 1, survey 2	40	76
SILT Follow Up Faculty Survey	34	76
SILT Spring 2014	36	75
SILT Summer 2014	27	75

Question 2: To what extent did teachers find their professional development in SILT to be effective and relevant to their practice?

Teachers perceived SILT to be relevant to their classroom practice and an effective use of their time overall. When asked to say whether they disagreed, strongly disagreed, agreed, or strongly agreed, teachers overwhelming said they either agreed or strongly agreed "I came away with something specific today that I will be able to use in my teaching this year." Table 10 below shows how teachers rated each day of SILT for which we have survey data.

Table 10.

Overall SILT Effectiveness of Relevance				
Day	**Year**	**Question**	**Rating (Agree and Strongly Agree)**	**Number of respondents**
1	2011	"I came away with something specific today that I will be able to use in my teaching this year."	79%	57
2	2011	"I came away with something specific today that I will be able to use in my teaching this year."	96%	56
3	2011	"I came away with something specific today that I will be able to use in my teaching this year."	100%	51
4	2011	"I came away with something specific today that I will be able to use in my teaching this year."	98%	49
5	2011	"I came away with something specific today that I will be able to use in my teaching this year."	100%	51
1	2012	"I came away with something specific today that I will be able toSILT use in my teaching this year."	88%	50
2	2012	"I came away with something specific today that I will be able to use in my teaching this year."	96%	66
3	2012	"I came away with something specific today that I will be able to use in my teaching this year."	93%	54
4	2012	"I came away with something specific today that I will be able to use in my teaching this year."	97%	50
5	2012	"I came away with something	90%	45

		specific today that I will be able to use in my teaching this year."		
1	2013	N.A	N.A	44
3	2013	*Teachers rated the effectiveness of each component of SILT.	June day = 68% Summer work = 81% 3 days in August = 96%	53
2014	May 23rd (Day 1)	"The learning was relevant for me."	91%	50

Data suggest teachers overwhelmingly perceived SILT to be an effective use of their time and relevant to their daily practice.

Question 3: To what extent did teachers learn from their professional development experiences in SILT?

Teachers' open-ended survey responses demonstrate teachers learned from their professional development experience in SILT. Components like built-in time to collaborate with various colleagues, the time to reflect on the day's learning, and the use of various kinds of expertise (students, teachers, and community members) surfaced repeatedly when teachers discussed what made the SILT experience effective, relevant, and meaningful. Teachers responded to the question, "What were the most important things you learned today" in the following ways:

- "Coming to a better shared understanding of the definition of PBL; why we should do it, how we should do it, and what we can do."
- "Thinking about the many ways (specifically authentic and relevant ways) to assess student learning, especially related to skills. Thinking about different ways of grading student learning, and what is really important, what we value."
- "Time to talk with both people in my discipline and from outside my discipline about how to use groups effectively in my classroom."
- "I had very fruitful conversations with colleagues – conversations that helped us process some ways we might collaborate in the future."
- "I feel like teachers' knowledge was utilized in the process, so it didn't feel top-down. I learned a lot from talking to other colleagues, learning about their instructional strategies, and further discussing PBL implementation with them was also beneficial. Also, I enjoyed attending teachers' presentations, so I could learn from my colleagues. It felt highly collaborative, which was an excellent model for what we are asking our students to do."
- "The cultural awareness panel discussion is perhaps the most effective teacher training day (outside of time to work in my room) I have ever spent. It was honest, practical, and powerful."
- "I really enjoyed K's presentation – it reminded me to never underestimate students or what they are capable of achieving."

Teacher responses evidence general and specific things they took from their experience in SILT and apply to their teaching practice. One teacher stated that they "have new ideas about the needs of my minority students. I also have new ideas of how to connect to them." Another stated that they "Learned of the many possibilities for incorporating PBL into all of my classes." While these and other responses like them represent somewhat ambiguous or vague ideas for how teachers' SILT learning could translate into different teaching strategies, others were more specific. One teacher stated they,

> Began to think about how expertise does not necessarily mean content knowledge, but can include identifying gaps in understanding and activating the resources to gain that knowledge. This more inclusive definition of an expert needs to be communicated to kids to really push the metacognitive processes of gaining expertise.

Another teacher talked specifically about how they wanted to leverage students' backgrounds as content for their classes saying, "Students can be used as cultural and social experts and could be a valuable part of the curriculum. Connecting their expertise with the content could make student engagement go up." Both the more general and specific ways teachers talked about their learning from SILT evidence the experience was beneficial to their learning as teachers.

PBL Curriculum Design Teams

PBL Design Teams consisted of teachers who volunteered or agreed to participate in a year-long curriculum redesign process with other teachers within their department who had experience teaching the course to be redesigned. Design teams met during an extra, common, daily planning period. Meaning, if the Biology design team met during 4th period, teachers on that team would meet every fourth period throughout the year. Design teams consisted of between 2 and 8 teachers, although most design teams consisted of 3-4 teachers.

Design teams largely worked autonomously. Teachers used the Key Elements to guide their PBL design work but also worked within the constraints of the established district curriculum, the Common Core State Standards (CCSS), the Next Generation Science Standards (NGSS), and various AP course frameworks and expectations. Depending on the course and discipline, some design teams experienced more rigid constraints than others. For example, the Advanced Placement Human Geography team enjoyed the benefits of designing a brand new course that had not been taught at the school before. Their primary constraints included negotiating the pedagogical principles set forth in the Key Elements with the established AP framework and expectations for the course, all the while planning curriculum that every incoming freshman student would experience. Alternatively, the Geometry team did not have to contend with AP framework but they did have to contend with the district common math curriculum, the Math CCSS, and with preparing students for a state mandated end of course (EOC) exam. Each team's work was highly complex and complicated but in ways that were specific to the course they were designing and the content area in which they taught.

Out of this process came profound teacher learning. While several teams struggled to navigate the web of competing standards, assessments, and expectations, virtually every design team teacher described the process as one the most fulfilling professional development experiences of their career. Like the PBL curriculum they worked to design for their students, teachers engaged in a daily process of creative and collaborative problem solving that deepened their content and pedagogical content knowledge and

expertise. For many teachers, this process made teachers into dedicated collaborators who learned to seek out the expertise of their colleagues to further refine and adjust lessons and units and to solve problems of practice.

School leaders assembled teacher PBL Design Teams to redesign established curriculum into problem based curriculum and to further build capacity and expertise within the teaching staff. Design teams were diverse according to teacher gender, years of experience, and expertise. Initially, the school chose teachers to serve on design teams if they had previous experience teaching the course to be redesigned. In years two and beyond, the school provided teachers with an opportunity to assemble their own teams and propose specific courses they wanted to redesign. What eventually transpired was a policy that balanced both the school's need to redesign certain courses and teachers' desire to prioritize curriculum redesign in some courses over others.

The design teams the school established more resemble teacher learning communities, popularized by Wenger (1998), than professional learning communities, popularized by DuFour (2004, 2005). Unlike professional learning communities (PLCs) design teams are not guided or governed by facilitators, district or school leaders, or consultants, nor are teachers expected to follow specific protocols or processes to complete their work. Instead, in design teams, teachers established the routines and norms that govern their collaborative work and the eventual product(s) that emerged from that process. Design teams represent a key fidelity component to the school's project implementation.

Design teams were assembled in most departments in the school, including Fine Arts, Physical Education, Social Studies, English, Math, Science, Foreign Language, the Performing Arts, and Career and Technical Education. Courses specific to Special Education and English Language Learners (ELL) were not redesigned.

For the most part, design teams operated autonomously throughout the school. It was highly uncommon for teacher leaders or school and district administrators to participate in design teams in which they were not already full members. Meaning, it was rare for district administrators, building administrators, or teacher leaders to drop in on design teams to observe the work they were doing or to offer support for how they structured their curriculum redesign work. Because teacher leaders from the Social Studies and Science departments commonly served on design teams as full members, it was uncommon for teacher leaders to check in on those design teams. An example of this was the Junior Level English Design Team who worked during the 2012-2013 school year. Field notes from observations of this design team evidence that out of 25 observations conducted throughout the year, a teacher leader or administrator visited the team twice to check in and provide them with support. The frequency by which teacher leaders or school leaders visited the Junior Level English team was a common occurrence among all the design teams studied.

Design teams served two important purposes in regards to the work of the grant. First, design teams were responsible for designing PBL curriculum. The school did not articulate a specific amount of PBL Design Teams were expected to redesign, only that they had to redesign some amount of curricula they could implement the year after the design year. In the first year of curriculum redesign, the school intended for design teams to redesign full courses during their year release. Although this remained a tacit goal for all future design teams, after the first year of design the school shifted focus to supporting the quality of PBL emerging from design teams throughout the school. Second, the school hoped the design

team experience would further build capacity and expertise within the teaching staff. Meaning, the school hoped design teams would evolve into rich contexts for teaching learning as teachers planned curriculum and shared problems of practice that emerged from the process of piloting redesigned curriculum. As teachers continued to engage in the curriculum design process, they would improve their practice and deepen their understanding of PBL pedagogy.

The data show that some teams chose to establish a design/pilot structure to their curriculum redesign process and some did not. Among the teams studied, the AP Human Geography and the Junior English exhibited the most pronounced structure of design/pilot in their redesign process. The data also show that out of the 6 design teams we studied, the AP Human Geography and Junior English teams redesigned the most curricula by the end of their design year.

In late fall of 2011, the school planned and facilitated a peer curriculum review process whereby teams would share some of the work they had completed up until that point. The purpose of this peer review process was to inject the curriculum redesign process with peer accountability. The school requested design teams create a presentation illustrating a partial or full unit of instruction they had planned and provide their colleagues with a document in which they would provide rationale and background for why they made specific curricular decisions. After design teams had time to read and digest the materials they received from their peer reviewers, they came together in a two-hour meeting to provide feedback to each other. Teacher leaders and school leaders facilitated these discussions.

The school implemented one round of peer review in Winter of 2012. A Sammamish teacher leader and a university researcher co-designed the peer review process. The purpose was to provide teams the time and space to reflect on their design work and gain feedback on the curriculum they had designed up until that point. Teams were paired with teams in other departments. Paired teams were to prepare a PowerPoint presentation to provide important background to the redesigned unit, a redesigned unit with all the relevant course materials, and a rationale for their decision making in regards to the unit. Once teams were assembled it was clear that teams were at various stages of planning resulting in some teams sharing very little and some teams sharing too much. In addition, some departments wanted more specific feedback on the specific content within each unit and felt as though the inter-disciplinary design of the review process provided them with too little actionable feedback in regards to content. After receiving feedback from participating teams, the peer review process was abandoned.

An additional notable feature of some design team's process was the occasional presence of external experts and/or representatives from partner organizations in the meetings. In some cases, university researchers partnered with design teams to conduct observations on their design process throughout the year or university professors would make weekly visits with design teams to help them think through specific problems they had encountered in the planning process. In some cases, design teams partnered with educational organizations to pilot externally designed PBL curriculum. In still other cases, design teams would schedule visits with representatives from industry to either receive feedback on the authenticity of specific units or in an attempt to engage them in more focused planning of unit assessments. However, not every design team engaged partners or representatives from industry and in those teams that did, they engaged those persons to varying frequency and intensity throughout the year.

Research Questions

In our analysis of how design teams functioned within the school and the extent to which they were effective in redesigning curriculum, we have asked the following questions of the data.

1. What did design teams accomplish? Did their design efforts result in curriculum they could implement?
2. How much curriculum did each team redesign? To what extent was the curriculum they redesigned PBL curriculum?
3. How did design teams structure their collaborative work? What similarities, if any, existed between teams?
4. How did participation in a design team affect the capacity of teachers to continue the work?

Findings Summary

1. The amount of curriculum each design team designed varied by team.
2. The extent to which the PBL Design Teams redesigned was/is problem based learning varies from team to team.
3. Teams that established a design/pilot structure to their curriculum redesign process designed more curriculum than those team that did not establish and design/pilot structure.
4. Departmental culture influenced how design teams structured their collaborative work.
5. Teachers stated learning more about teaching from their experiences working on a design team.

Methodology

We collected data on design teams during the 2011-2012, 2012-2013, and 2013-2014 school years. In the following table we describe the design teams we studied, when we studied each team, and the data we collected on each team. Our findings on teacher design teams are partially gleaned from a concurrent study conducted at Sammamish High School focused on the implementation of PBL throughout the school. The researcher who conducted this study is also a research associate for Knuth Research. This study followed a total of 6 design teams over the course of 3 years. Table 11 below describes what data was collected on which design teams and when that data was collected.

Table 11.

Teacher Design Team Data Summary				
Design team	**Year**	**Data collected**	**Frequency of data collection**	**Curriculum successfully redesigned by end of design year**
AP Human Geography	2011-2012	Video recorded design team meetings Semi-structured teacher interviews Document review	Weekly design team meeting observations (September-March) Interviews conducted in Fall and Winter Documents collected throughout the year	A full year's worth of curriculum
Freshman English	2011-2012	Video recorded design team meetings	Weekly design team meeting observations (September-March)	3 complete units

		Semi-structured teacher interviews Document review	Interviews conducted in Fall and Winter Documents collected throughout the year	
Sophomore English	2011-2012	Video recorded design team meetings Semi-structured teacher interviews Document review	Weekly design team meeting observations (September-March) Interviews conducted in Fall and Winter Documents collected throughout the year	No completed units
Geometry	2012-2013	Video recorded design team meetings Semi-structured and stimulated recall teacher interviews Document review	Daily design team meeting observations • 1 week in September • Teachers planning a PBL unit in winter/late fall • 1 week in June Interviews conducted during each group of design team meetings (Fall, Winter, Spring) Documents collected throughout the year	Mini-challenge cycles within larger units. 1 complete unit.
Junior English	2012-2013	Video recorded design team meetings Semi-structured and stimulated recall teacher interviews Document review	Daily design team meeting observations • 1 week in September • Teachers planning a PBL unit in winter/late fall • 1 week in June Interviews conducted during each group of design team meetings (Fall, Winter, Spring) Documents collected throughout the year	4 complete units
*Senior English	2013-2014	Video recorded design team meetings	Daily design team meeting observations in Fall Interviews conducted in Fall	N.A.
*American Studies[5]	2013-2014	Video recorded design team	Daily design team meeting observations	N.A.

[5] Data from the AP American Studies and Senior English teams is incomplete and thus not used in this report. For various reasons, these teams chose to use their design year solely to redesign and not implement curriculum. These teams were studied

(combo of AP U.S. History and AP Language)		meetings	• 1 week in Fall • Teachers planning a PBL unit in Winter	

In sum, our teacher design team data corpus includes 127 teacher design team meeting video recorded observations, 34 interviews, and extensive teaching artifacts collected during the data collection process. Interviews were transcribed by the researcher and member checked with each teacher to validate the transcription and the content of the interview. Data collection was not completed for either the Senior English or American Studies teams in the 2013-2014 because these teams did not implement and/or pilot curriculum concurrently with curriculum redesign.

Findings

In the following section, we present our findings in two ways. First, we present data to evidence the extent to which PBL Design Sessions rate highly according to our fidelity measures. These measures include an analysis of 1) teacher exposure to design teams and design sessions, 2) design session quality as defined by the extent of their support from external design mentors, and 3) design session quality as defined by the extent of their support from external content mentors. Second, we use our data to more fully answer the research questions regarding PBL Design Sessions stated above.

Fidelity measures

Our data show PBL Design Sessions were implemented with a moderate degree of fidelity.

PBL Exposure

Each PBL Design Teams had the opportunity to meet approximately 140 times throughout the school year. Each design team was provided a common, daily release to redesign curriculum. Each design team had the opportunity to meet at least 4 times during each full week of school. Three of the days they would have met during the week were during 50-minute periods. One of the day they would have met would have been during a block, 90-minute period. Because we did not conduct daily observations of each design team throughout each year, it is entirely possible that the extent to which each design team used their design period to meet as a team varied according to the day's schedule, whether or not one of the members was out sick, or whether or not the team decided they did not have to meet on any particular day.

Question 1: What did they accomplish?

The amount of PBL curriculum each design team designed varied by team. The amount of curriculum each team planned and the specific constraints and affordances each team faced when implementing the curriculum led to uneven levels of curriculum implementation the following year. For example, the AP Human Geography designed a vast majority of the PBL units they were going to teach in their implementation year during their design year. Conversely, the Algebra 2 team redesigned approximately half of the units they were going to implement the following year but the district

by researchers from the University of Washington and were dropped from their research because they chose not to pilot newly designed curriculum during their design year.

dramatically shifted the focus of the curriculum in the summer between design and implementation years, leaving them with little to implement.

In addition, some teachers described feeling constrained by the standardized high stakes tests their students would take at the end of the year in their design process. For courses such as Geometry, BioChem, and AP Chemistry, teachers struggled to plan deeply engaging PBL units while teaching students enough content to ensure they were prepared to pass the associated end of course (EOC) exam, the Advanced Placement (AP) exam, or various district assessments. A teacher on the Geometry design team described how

> It's, it's limiting in creativity in my view. Like, be creative with PBL, take these kids where they haven't been before, make them think in ways they haven't before, but you have to do this [district curriculum/assessments]. And you have to do it in this time and you have to give this test by this date and, you know, it's just like, we have to give district assessments. You have to make sure you cover these, this, this topic and you have to make sure you have to hit these things but, do whatever you want. Do whatever you can, you know, have fun with it! Be creative! Go places! And you know, it's just putting a cap on how creative you can be.

This tension between teaching the content demanded by various layers of testing and external assessments and the creativity demanded of teachers to design high level PBL units was difficult for teachers of these kinds of courses to balance.

Question 2: How much curriculum did each team redesign? To what extent was the redesigned curriculum PBL?

The quality of PBL curriculum each design team planned varies widely from team to team. Over the course of 4 years, approximately 35 design teams have redesigned 35 courses. Each team was provided one year to redesign existing curriculum. After the design year, teams continue to implement multiple versions of lessons and units as they get a better sense of how curriculum can be improved according to PBL pedagogy. Each team approached the design process differently and each team redesigned different amounts of the existing curriculum.

Establishing the quantity and quality of PBL curriculum each team designed is problematic for several reasons. First, the standard of PBL the school has been aiming at has shifted from the beginning of the project. In part this was because the Key Elements document itself has dramatically shifted over time. The first version of the Key Elements document Year 1 and 2 design teams used was a mere two pages and articulated each key element broadly. Sammamish High School teachers and a university researcher rewrote the Key Elements document starting in Year 2 of the project. They were responding to feedback from teachers who said the key elements were too general to be of any use as they designed curriculum. As teachers gained more expertise through the design and implementation process, the Key Elements reflected the school community's burgeoning expertise in PBL pedagogy.

Not only did each teacher on each team approach the redesign process with varied levels of expertise of PBL pedagogy, each team dealt with slightly different constraints as they worked to redesign curriculum. These constraints included: 1) the extent to which the content of each course lended itself to PBL pedagogy, 2) the extent to which each course was accountable to a specific end of course high stakes

test, and 3) the extent to which each course was beholden to existing district curriculum. For each course and design team, these constraints manifested themselves differently, forcing each design team to adjust the extent to which they felt lessons and units could be redesigned into PBL curriculum.

Question 3: Did all design teams operate in the same manner? If not, why?

Design teams did not operate in the same manner. Design teams approached the curriculum redesign task differently for several reasons. First, in many cases design teams adopted the norms and culture that exists within departments. In some cases, design teams evidenced strong and equitable patterns of collaboration while other teams evidenced hierarchical and at times confrontational patterns of collaboration. Second, some design teams leveraged cycles of design and implementation/pilot during their design team year while other teams chose to use the design year to design only, and not implement and/or pilot newly designed curriculum. Third, external constraints having to do with standardized testing such as end of course exams and AP exams factored into how much curriculum teams could redesign and what kind of PBL teams designed. Fourth, team chemistry factored into how teams structured their collaborative curriculum redesign.

Design team collaborative routines. The data suggest variability in how teams structured their collaborative practice. For example, the Junior and Freshman English team generally approached curriculum redesign with enthusiasm and excitement. However, both teams struggled from time to time with recurring debates having to do with the role of the novel or literary analysis essays in PBL English classes. Within these teams, how the department as a whole generally thought about these issues served as touchstone or starting point for discussions.

The data from two design teams show a positive relationship between teams that routinely shared teaching artifacts from cycles of implementation and teams that produced large amounts of PBL curriculum. The AP Human Geography team's design team data evidenced a strong routine of sharing teaching artifacts that reflected recently implemented or soon to be implemented curriculum. At the end of their design year, the AP Human Geography team redesigned nearly a whole year of PBL curriculum. Table 12 illustrates all the design team meetings we observed and the extent to which teachers shared teaching artifacts in those meetings. We observed the AP Human Geography team 11 times from mid-September to mid-March during the 2011-2012 school year. In the 11 observations we conducted, the AP Human Geography team shared a teaching artifact 12 times.

Table 12.

Instances of Sharing in AP Human Geography Design Team Meetings											
Topics	**9/15**	**9/22**	**10/6**	**10/27**	**11/3**	**11/17**	**1/5**	**1/12**	**1/26**	**2/9**	**3/8**
PowerPoint lesson plan for the day	**X**			**X**			**X**		**X**		
Student survey		**X**									
Developing a student classroom task or activity			**X**		**X**		**X**				
Developing a student assessment and/or rubric for the assessment				**X**		**X**		**X**			
Teachers discuss various subject matter content										**X**	

In table 12, "X" stands for instances where teachers shared a problem of practice and that sharing led to a focused discussion amongst teachers.

Throughout their design year, this team simultaneously planned and implemented newly designed PBL curriculum. In the design team meetings we observed, teachers routinely used shared artifacts to focus and ground their discussions around what was working and not working and why. By the end of the year, the AP Human Geography team had redesigned nearly a full year of curriculum, most of which had been piloted and revised. The team started their first year of implementation with curriculum that had undergone one cycle of design, implementation, and revision.

The Junior level English team evidenced similar levels of sharing throughout the year in a similar number of design team meetings. We observed the Junior English team 25 times throughout the 2012-2013 school year. Table 13 below illustrates a subset of those observations when we observed the team redesigning the Satire Unit in November and December of 2012. Data from the Junior English team evidences that they routinely shared teaching artifacts in their design team collaboration. In this sample of 10 design team meetings, this team shared 9 different kinds of teaching artifacts, 18 times.

Table 13.

Instances of Sharing in the Junior English Design Team's Satire Unit										
Topics	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Student surveys (design, data analysis, feedback)	**X**		**X**	**X**				**X**	**X**	**X**
Scaffolding note-taking strategies	**X**									
Class manifesto	**X**									
Teacher developed model essay	**X**									
Student peer evaluation/self evaluation handout		**X**								
English content handout (various)				**X**			**X**			
Unit calendar							**X**			
Various student work/artifacts						**X**			**X**	
Lesson plans					**X**		**X**	**X**		

In table 13, "X" stands for instances where teachers shared a problem of practice and that sharing led to a focused discussion amongst teachers.

As with the AP Human Geography team, the Junior English team routinely shared teaching artifacts in their design team meetings. The artifacts they shared typically represented newly designed teaching materials from PBL units. Similarly to the AP Human Geography team, by the end of their design year the English 3 team had redesigned nearly a full year of curriculum, most of which had been piloted and revised. The team started their first year of implementation with curriculum that had undergone one cycle of design, implementation, and revision.

In contrast, Table 14 below evidences markedly less sharing in the Geometry design team. We tracked the extent to which teachers shared teaching artifacts, in a group of 9 design team meetings, as they planned a PBL unit in January 2013.

Table 14.

Instances of Sharing in Geometry Design Team Meetings									
Topics	**1/14**	**1/15**	**1/16**	**1/18**	**1/23**	**1/25**	**1/29**	**1/30**	**2/8**
Looking at student grades for each Math 2 course					**X**				
Rubric for student project									**X**

In table 14, "X" stands for instances where teachers shared a problem of practice and that sharing led to a focused discussion amongst teachers.

The Geometry design team shared far fewer teaching artifacts than both the AP Human Geography and Junior English design teams. They also had produced less curricula by the end of their design year. By the end of the school year, the Geometry design team redesigned "about a third" of a year's curriculum into PBL curriculum.

Our data suggest, as does the research literature (Cochran Smith and Lytle, 1999; McLaughlin and Talbert, 2006; Horn and Little, 2009), that sharing artifacts and problems of practice can impact the extent to which teachers learn from collaboration. When this specific routine was present in design team's collaboration, other productive interpersonal features also seemed to be present. For example, sharing between all teachers within a design team, especially in those teams where novice teachers were members, imply that teachers also established clear norms to guide their collaboration and that they developed a shared commitment to the work of PBL redesign. Our data suggest that both features are indicative of productive teams. For example, both the Geometry team and the Sophomore English team eschewed norm setting as a legitimate component of collaborative work. In both cases, some teachers were hesitant to explicitly embrace PBL as a legitimate curriculum redesign goal. Conversely, in both the AP Human Geography and Junior English team, part of the norm setting process was to unearth philosophical differences between teachers regarding PBL pedagogy. In some teams, when teachers set clear norms and sustained a commitment to PBL throughout their redesign process, they established predictable routines within the team to allow for disagreement and dissent. In the teams where this did not happen, philosophical tensions and disagreements between teachers made the process of PBL redesign more complex, complicated, and potentially contentious as the year progressed.

Question 4: How did participation in a design team affect the capacity of teachers to continue the work?

When interviewed, teachers largely found the design team experience valuable regardless of their overall design team experience or the department in which their design team was situated. An experienced English teacher, who was resistant to PBL, commented that he was "trying lots of new things [throughout] the year." Design team learning was especially powerful for the novice teachers who worked on a team. A first year Math teacher spoke about how

> As a first year teacher, it was a lot harder for me to see the big picture. There are little things I think I am picking up from them [the design team] on how I

> approach the little things and the big things…My belief system has evolved. I've learned from their mistakes too.

An experienced Social Studies teacher commented that "compared to everything I have ever done in terms of, you know, professional development, working with other teachers in a design team has been the best professional development experience I have ever had." When asked to describe further what it was about the design team experience that was so powerful for their learning, many teachers commented that the daily, scheduled time to collaborate with colleagues helped them was pivotal for their learning.

Beyond the learning teachers experienced through the PBL Design Team experience, many teachers spoke about the respect they felt as a result of membership on a design team. An experienced English teacher described working on a design team as "the closest [I've] gotten to [feeling] like a professional and to feel[ing] like the school trusts and puts power in the teacher." This same English teacher talked about the expectation of creative thinking and problem solving that came with working on a design team and how "there hasn't been an opportunity for me to be this creative in a really long time." To many teachers having predictable, extended time to work with other teachers about curriculum and instruction was refreshing. An experienced teacher in the English department stated that

> Never before have I felt like I was encouraged to actually take a meaningful amount of time to talk about what I do in the classroom…The notion that we are actually, somebody is giving us the time and, and, taking note that that is an actual, in fact a vital part of instruction, of good instruction at the very least, um, is the ability to have time to do your planning and talk about practice…That feels good.

The data is rife with testimonials from teachers that evidence a newfound respect they felt as design team teachers and a belief that they had learned more about teaching and learning from their collaboration with design team colleagues.

Additionally, there is some evidence that some teachers have transferred the knowledge gained from redesigning curriculum into planning and informally redesigning other courses they teach. A teacher in the English department who participated on two design teams used strategies learned from those experiences to informally and incrementally redesign an Advanced Placement Language class he taught. One of the literacy specialists at the school used the knowledge she gained from planning the Sammamish Leads project to redesign her AVID classes. Examples like these suggest that teachers use their knowledge of the curriculum redesign process and of PBL to inform how they plan and teach other courses that have not been formally redesigned according to PBL pedagogy.

Alternatively, teams that did not establish collaborative routines such as examining problems of practice, also seemed to struggle to build the kind of capacity within the team that would help them sustain the iterative, curriculum redesign process as teachers continued to implement the curriculum. In the teams where this dynamic was present, there also existed a strong ethos of teaching privatism (Little, 1990; Hargreaves and Fullan, 2012).

In meetings conducted with departments in the Spring of 2014, some teachers described a relationship between curriculum redesign release time and the status they perceived the school conferred upon design team teachers as a result of their design team experience. Meaning, some teachers equated design team release as a kind of currency or commodity only some teachers were offered. Teachers from the English department expressed resentment towards the amount of release time teacher leaders were

provided for managing the grant work throughout the school. These teachers questioned the integrity of some teacher leaders who they saw as having less PBL teaching experience than they had. Teachers from the CTE department expressed resentment for what they perceived as the paltry amount of release time provided their department for curriculum redesign. This perception among some teachers was unexpected and surprising.

The influence of departmental culture. In most cases, design teams structured their collaboration in ways similar to how collaboration functions in departments. A teacher on the Geometry team described how the team "Didn't really do that norming process thing at all…we put that off. It was just kind of natural, I think teacher A and I, having worked together the year before, it was sort of our routine already. So it just trickles down from the math culture that we have here." A teacher on the AP Human Geography team described how the culture of the group was an extension of the Social Studies department. She described how the department "collaborates a lot" and how "at lunch we [they] talk about how we [they] can work together better as a department." A teacher on the Sophomore English team described how the department tends to adjust whatever school-wide improvements the school implements to what they are already doing in their classes. When asked about how he and the department thinks about PBL redesign, he stated, "We're [the department] gonna put a project on the end of it [established curriculum]. People go, 'Oh, that's PBL right? Project-based learning?' Yeah. That's what it is. Um, and in the process we'll try and sneak in some of the 'actual' education, some of the 'actual' problem solving that we've always done." The opinions of these specific teachers were not necessarily consistent with each teacher within each department. However, our data suggest they represent the overall opinions, beliefs, and dispositions present within each department.

In each case, design teams transplanted the departmental culture into their design team structure but with different results. In the case of the AP Human Geography team, they transplanted a strong collaborative culture in which teachers would openly share their personal instructional practice and debate the best ways to address issues they encountered when implementing the curriculum. Interviews and informal conversations with various Social Studies teachers evidenced a group strongly supportive and enthusiastic about the potential of PBL to transform how they taught Social Studies content to students. In the case of the Sophomore English team and to a lesser extent the Geometry team, both teams transplanted a strong entrepreneurial bias and traditional culture in which teachers were expected to teach their classes in ways that best fit their teaching styles. Meaning, teachers in both teams took a largely content-centric perspective of teaching Math and English coursework that was biased toward how they were taught those classes as students. Teachers who held this perspective tended to resist collaborative problem solving and planning and preferred to teach in more isolated, private classrooms (Lortie, 1974). Reflecting the dominant attitude within the English department and to a lesser extent within the Math department, many of the teachers on these teams remained suspicious of how PBL redesign might change or shift the traditional content foci within each discipline.

Chapter 5: School Leadership Structure

This section examines the school's leadership structure, including the teacher leaders, and how these leaders supported teachers in their transition to problem-based learning. This project pushed the traditional boundaries of what schools expect from principals, teacher leaders, and teachers. Much of the time teachers and school leaders were working with a vision but without a clear blueprint to get them from point A to point B. From time to time this tension caused inevitable conflict and second-guessing by everyone involved in the project. Beyond providing a description of how the principal and school leaders redesigned the school's leadership structure, we use qualitative data to provide a candid view of what worked and did not work from the perspective of teachers, teacher leaders, and school leaders.

Teachers face various obstacles when designing and implementing PBL curriculum. The most complicating factors include:

- Lack of *experience* designing and implementing PBL curriculum (Albion & Gibson, 2000; Ward & Lee, 2002),
- The *time* it takes implementing high quality PBL curriculum and, conversely, the time PBL curriculum takes away from teachers' ability to directly teach to various high stakes tests (Ward & Lee, 2002; Brinkerhoff & Glazewski, 2004; Park, Ertmer, & Cramer, 2004; Simons, Klein, & Brush, 2004),
- PBL demands a different approach to *assessment* that can move teachers away from more traditional forms of assessment like multiple choice exams and essays (Benedict, Thomas, Kimerling, & Leko, 2013),
- Lack of strong *models* of high quality PBL curriculum in multiple content areas (Ertmer, Lehman, Park, Cramer, & Grove, 2003), and
- Teaching and learning in a PBL context also demands that teachers and students embrace *different roles* (Gallagher, 1997; Brush & Saye, 2000; Land, 2000; Ertmer et al., 2003; Ertmer & Simons, 2006; Grant & Hill, 2006).

In addition, the roles teacher leaders take up can be challenging as they support teachers who work to design and implement PBL curriculum. The extent to which Sammamish High School teachers addressed these and other pressures in their work to support teachers is the focus of this section.

Purpose of Leadership Team

The purpose of the leadership team was to support the design and implementation of PBL across the school in an effort to increase college and career readiness. Rather than bring in consultants or an externally created PBL curriculum, the principal believed that developing teacher expertise and teacher capacity was a "big part" of the grant.

Methodology

Data collection and analysis for this section of the evaluation was conducted between 2014-2015. By 2014, all of the members of the evaluation team had started to form opinions on what was going on in the school. The evaluation team considered it both wise and necessary to ask someone *not* familiar with the Sammamish High School i3 Grant work to conduct research on the leadership structure established at the

school. Two to three times a year, the researcher would travel to the Pacific Northwest to collect qualitative data. In between visits the researcher would transcribe and analyze audio recorded interviews and focus groups. While the larger research team had some knowledge of the protocols the researcher was using and the data he was collecting, much of the analysis was performed between visits.

Data on the School Leadership Structure was collected during the 2014 and 2015 school years. In order to learn about the principal's role in the grant and implementation process, he was interviewed five times over the course of the 2014-2015 school year. Each interview lasted between one and three hours. All interviews were audio recorded and transcribed for analysis, and all but one took place in a face-to-face setting. Findings were developed iteratively, over multiple rounds of analysis of the date, through a grounded theory approach (Erickson, 1986; Strauss & Corbin, 1998). As more themes surfaced from the process of data analysis, we adjusted our questions and interpretations.

Each teacher leader was interviewed at least twice at various points throughout the 2014 and 2015 school years, with the exception of one member of the leadership team who left the school at the end of the 2014 school year. Teachers were strategically identified to gather the full range of opinions and perspectives regarding the PBL work of the grant. Teachers were identified over several meetings with the research team for this evaluation. As with interviews conducted with the principal, all teacher and teacher leader interviews were audio recorded. All department focus groups were also audio recorded. All interview data was triangulated with school and grant documentation, department focus groups, principal interviews, and other interviews with teachers and teacher leaders.

Leadership Team Membership

The core school leadership team for the grant, originally called the Implementation Team for part of the first year, consisted of the following people:

1. Principal (also served as the Project Director with no additional pay)
2. Grant manager (external hire, non-teacher)
3. i3 project leader
4. i3 project leader
5. i3 project leader
6. Teacher leader/Instructional Curriculum Technology Leader (ICTL)
7. Teacher leader/Literacy Coach
8. Teacher leader/ELL Coach

The full Implementation Team was formed in February/March 2011 and the Implementation Team and the Instructional Leadership Team (ILT) were merged to into one leadership team in May 2011. According to the principal most leadership positions were open, meaning anyone in the school could have applied. Ultimately two i3 project leaders were teachers who had been significantly involved with the grant application process. One project leader had previously been involved in a Project-Based Learning curriculum redesign project, thus had first-hand experience transitioning from a more traditional curriculum to a more student-centered curriculum like PBL.

The core leadership team grew from three members during the initial year to approximately eight members by the end of the grant. Although the grant manager position was not funded the last year of the grant, the same individuals served as the core leadership team during most of the five years. For an overview of all teacher leaders and their responsibilities throughout the grant period, please see Table 15.

Peripheral Members of Leadership Team

At various times additional members were funded to complete specific leadership tasks. These members weren't considered to be official members of the leadership team and were not required to attend leadership team meetings, but were funded to work on, as one teacher put it, "leadership activities".

- Teacher Leader [English Teacher]
- Teacher Leader [English Teacher]
- Studies Teacher Leader [Social Studies]

These peripheral members were mostly active during the last two years of the grant and assisted with developing materials and information for external audiences (e.g., articles about SHS and PBL for websites).

Leadership Team Roles

The principal and the teacher leaders all had distinct roles and responsibilities. Some of these roles and responsibilities remained constant throughout the grant and some of these shifted to address needs of teachers, and to fulfill the obligations and expectations of the grant. This section provides an overview of the roles and responsibilities of the principal and the teacher leaders.

Overview of the Role of the Principal

In general terms, the principal described his role as "chief planner" and described key aspects of his role as Project Director and school leader as:

- Person thinking the most about systematic change over time
- Facilitating and managing the change process
- Building teacher leadership capacity
- Ensuring implementation has fidelity with the grant
- Celebrating successes along the way
- Problem-solving

Specifically, the principal's role as Project Director and school leader can be outlined in three phases: building the foundation, facilitating the process, and extending the reach, that roughly coincide with the year one, years two through four, and year five of the grant.

Building the Foundation (Year 1)

During year one, the principal's main role was to build a foundation for the successful implementation of the grant over a five-year period. This primarily involved building relationships, establishing partnerships, and setting expectations for key stakeholders in the district office, school, and community. The principal understood and communicated to staff that innovation takes risk and the reality of an "implementation dip" as change begins. One key aspect of setting expectations for the project was communicating to stakeholders that implementing PBL and other aspects of the grant were going to be "substantial change, and that it was likely that when we started it, things, at times, [might] not go well." Other primary responsibilities of the principal during year one included:

- Writing job descriptions for grant leadership positions (grant manager and teacher leaders), in collaboration with a university researcher
- Working with bargaining units and district human resource department to get leadership positions approved
- Hiring a grant manager and teacher leaders
- Organizing and facilitating the grant leadership team to begin implementing the transition to PBL curriculum
- Identifying individuals for the grant Advisory Board
- Developing initial version of Key Elements in partnership with teacher leaders, university researchers, and Knuth Research
- Meeting with district administrators and curriculum personnel to develop common expectations for PBL curriculum development and professional learning

Facilitating the Process (Years 2-4)

The role of the principal in year one was focused on setting the stage for successful implementation of the grant and taking initial steps to begin the curricular and cultural shift at the school. Once work was underway, the second phase required a long-term focus on supporting teachers as they shifted their practice and developed professional expertise in PBL. During this time, shifts in implementation strategies took place (e.g., moving from a prescribed list of courses to be redesigned to an application process by interested teams of teachers) and teacher supports like the Key Elements were revised and refined. In general, the principal's role shifted to one focused on facilitating the change process, maintaining focus on implementing the grant with fidelity by responding to feedback and making strategic and practical changes as necessary. The main responsibilities of the principal during this period included:

- Maintaining long-term focus on implementing grant goals in the face of evolving district priorities, shifting academic standards, and changing school and district personnel
- Continuing to set expectations and tone for the change process
- Facilitating alignment of goals and expectations between PBL design teams, district supervisors, and district curriculum developers
- Working with teacher leadership team to develop and implement professional learning and supports so middle and late adopters moved forward in the change process
- Working with teacher leaders and a university researcher to refine Key Elements so they better support curricular and cultural shifts occurring at Sammamish
- Strategically hiring new teachers who were aligned with school goals and had demonstrated professional collaboration in previous work
- Building internal leadership capacity and problem-solving ability of teachers
- Building relationships with direct supervisor(s) in an effort to support the ongoing work at the school
- Ensuring work with external partners was aligned with school's goals, and when necessary, changing or ending relationships
- Gathering feedback from key stakeholder groups and making strategic adjustments as necessary

- Maintaining communication between key stakeholders
- Celebrating successes

Extending the Reach (Year 5)

After the initial year, the primary role of the principal was to maintain long-term focus on supporting teacher development and change as they shifted their instructional practice and developed professional expertise in PBL. In the final year of the grant, the principal continued to work with the leadership team to support teacher growth and engagement with the project. He also worked to ensure that goals and obligations outlined in the grant were met. At the same time, there was an outward shift in focus. Curricular and cultural changes at Sammamish were communicated beyond the school through a variety of channels and the principal looked to build external partnerships that would help Sammamish continue the work after grant funds were gone. The main responsibilities of the principal during this period included:

- Cultivating new partnerships with community stakeholders and organizations for the purpose of extending the impact of the grant at Sammamish, within the district, and across the larger education community
- Deepening and redefining established partnerships to ensure Sammamish is continuing to receive value
- Working with leadership team and teachers to revise the teacher leadership structure so more stakeholders feel involved and heard
- Mediating new district initiatives that could take focus away from the change process and meeting goals outlined in the grant
- Facilitating further refinement of the Key Elements and their integration into the new teacher evaluation system (based on the Danielson framework)
- Collaborating on a book, and presentations for local and national education conferences
- Facilitating outreach tours of Sammamish with groups of local, national, and international visitors
- Maintaining focus on long-term change by planning for "after the grant"
- Continuing to set expectations and tone for the change process so teachers would continue to develop and collaborate
- Strategically hiring new teachers who were aligned with school goals and had demonstrated professional collaboration in previous work
- Ensuring work with external partners was aligned with school's goals, and when necessary, changing or ending relationships
- Maintaining communication between key stakeholders
- Communicating with teachers that PBL was going to be a continued focus of the school

Role of Teacher Leaders

While individual teachers on the leadership team had specific roles and responsibilities (see Table 15), as a group they were responsible for facilitating implementation of the grant. This teacher leadership team, along with the principal, was responsible for ensuring all aspects of the grant were being addressed and that the school was following through with the plans outlined in the grant application. The role of the

leadership team as a group can be outlined in three phases similar to the role of the principal. A phrase repeated by the leadership team was "building the plane while flying," meaning the team was simultaneously engaged in thinking long term about supporting professional learning and deepening the implementation of PBL throughout the school and "putting out fires" like planning the next school visit or running off to a meeting with other school leaders within the district. While each teacher leader fulfilled specific roles within the team, such as PBL Implementation Lead or Starting Strong/SHS Leads Coordinator, their roles were also somewhat fluid and every-changing depending on the very immediate and urgent needs of the project at that time.

Building the Foundation (Year 1)

A large part of this first year was spent identifying and hiring teachers for the teacher leadership team. The Implementation Team, not fully formed until February/March initially only consisted of the Grant Manager and two Project Leaders. Near the end of the year (May 2011), the Implementation Team and the Instructional Leadership Team (ILT) were merged into one leadership team. During year one, primary responsibilities for the leadership team included:

- Identifying individuals for the grant Advisory Board
- Developing initial version of Key Elements in partnership with principal, university researchers, and Knuth Research
- Organizing the mentoring program
- Revising Starting Strong
- Devising a communication plan (e.g., using OneNote, capturing gained knowledge, feedback mechanisms, collaborative process, school website)
- Planning staff meetings and board presentations
- Planning PBL PD on release days in May
- Planning first Sammamish Institute of Learning and Teaching (SILT)
- Reviewing budgets and staffing for PBL redesign teams

Facilitating the Process (Years 2-4)

During this stage of the project, teacher leaders spent much of their time supporting teachers as they worked to design PBL curriculum in design teams and implement PBL curriculum in their classroom. This support mostly included designing professional learning experiences based on feedback they were receiving from teachers. At the end of year three and throughout year four, teacher leaders were increasingly involved in managing and facilitating school visits as other schools, districts, and educational organizations became interested in what was happening at the school. The main responsibilities for the leadership team during this period included:

- Maintaining long-term focus on implementing grant goals in the face of evolving district priorities, shifting academic standards, and changing school and district personnel
- Shifting course redesign from being prescriptive to application-based where teacher teams apply to redesign a course (year X?)
- Developing and implementing professional learning and supports so middle and late adopters moved forward in the change process

- Expanding, revising, and refining Key Elements to better support curricular and cultural shift

Extending the Reach (Year 5)

At this point in the project, teacher leaders spent much of their time establishing an organizational structure for interacting with external partners and organizations that were interested in the work going on at the school. At the end of year four and throughout year five, several teacher leaders were intimately involved in revising and publishing the Key Elements document to an audience outside the school. The main responsibilities for the leadership team during this period included:

- Cultivating new partnerships with community stakeholders and organizations for the purpose of extending the impact of the grant at Sammamish, within the district, and across the larger education community
- Working with the principal and other teachers to revise the teacher leadership structure so more stakeholders feel involved and heard
- Further refinement of the Key Elements and their integration into the new teacher evaluation system (based on the Danielson framework)
- Collaborating on a book, and presentations for local and national education conferences
- Facilitating outreach tours of Sammamish with groups of local, national, and international visitors
- Maintaining focus on long-term change by planning for "after the grant"
- Continuing to set expectations and tone for the change process so teachers would continue to develop and collaborate

Table 15.

Overview of Teacher Leaders, Department Affiliation, Major Responsibilities, and FTE

Position Title	Department	Responsibilities	Grant-funded FTE				
			Y1	Y2	Y3	Y4	Y5
Grant Manager	N/A – Not a teacher	• Preparing annual reports • Developing, managing, maintaining budget • Managing contracts • Ensuring compliance • Providing logistical support for events • Communications	1.0	1.0	1.0	0.5	
i3 Project Leader	Social Studies	• Worked on i3 grant • PBL Professional development • PBL curriculum design team support • Revising Key Elements • Help support UW TCs during Sammamish Leads • Sharing the Sammamish story with external audience	0.4	0.4	0.7	(Maternity Leave Sept-Dec 2013) 0.6	0.4
i3 Project Leader	Science	• Mentorship • Community outreach • Engaging outside experts • Support PBL professional development • School website development • Took the lead with creation of the Advisory Board, planning and running all four Advisory Board meetings per year, and maintaining on-going communication with Board	0.4	0.6	0.6	0.4	0.4
Teacher Leader	Literacy Coach	• Sammamish Leads		0.2	0.2	0.2	0.4

		• Support PBL professional development		(0.2 from LAP/Title I funds)	(0.2 from LAP/Title I funds)	(0.2 from LAP/Title I funds)	
i3 Project Leader	Science	• One of the primary i3 grant writers (prior to working at school) • Support PBL curriculum development • Teacher coaching and facilitation around PBL • Revising Key Elements • PBL Design team support • Hosting site visits			0.6	0.6	0.4
Teacher Leader	Instructional Curriculum Technology Leader (ICTL)	• Support teachers use of instructional technology • Coordinating work between school and district curriculum department • Teacher evaluation system support • Support PBL and technology professional development		BSD	BSD	BSD	BSD
Teacher Leader	ELL Coach	• English language learner advocacy and support • Support PBL professional development • Served in ELL support role on English design team 0.2 [Y3]			0.2	0.2	

Leadership Team Meetings

The school leadership team met weekly throughout the duration of the grant, and this opportunity to meet weekly was funded through grant monies. The researcher was provided access to the leadership team meeting agendas recorded in Microsoft OneNote. OneNote was used to record meeting agendas and at times meeting notes and other relevant files and documents. This OneNote notebook was available for anyone working at the school to view. In the school leadership team meetings OneNote file, 151 leadership team meeting agendas were recorded, starting on April 12, 2011 and ending on June 17, 2015. These meetings generally occurred once a week starting at the beginning of each school year (except year 1) and concluding at the end of the school year. Meetings also did not take place during times that school was not in session (e.g., holidays, winter break, spring break).

The purpose of these weekly leadership team meetings was to discuss issues related to grant implementation, instruction, and leadership. Meeting topics were related to discussing and planning:

- Grant and grant implementation
- District and state assessments and student achievement data
- Roles, responsibilities, and goals of leadership team members
- Starting Strong/Sammamish Leads
- Communication about grant
- Staff meetings
- PD for staff (e.g., SILT, other PD days)
- Advisory Board meetings
- Presentations (e.g., School Board, external groups)
- Visits by outside groups (e.g., other schools and districts, Microsoft executives)
- Sources and methods of obtaining additional funding

Advisory Board Meetings

The leadership team was also responsible for forming and meeting with a grant Advisory Board. According to the i3 grant application, the Advisor Board's purpose was to provide:

- Program guidance for STEM college readiness and career preparedness
- Assistance with securing resources and
- Assistance with scaling by leveraging professional connections
- Assistance with seeking funding to support project implementation in new settings

For most of the first year, the leadership team was identifying individuals who could serve on the Advisory Board. Membership on the Advisory Board shifted several times throughout the duration of the grant. In general, Advisory Board members included representatives from the partner university, from local business and industry, and from within the administrative ranks within the school district. Typically meetings lasted from 2-3 hours and provided school leaders and the Advisory Board with a chance to discuss progress the school was making and to discuss various problems that surfaced. During year two the Advisory Board met approximately three times. During years three and four the Board met 4 times each year. Generally, meetings occurred twice in the fall and twice in the spring. Meeting dates recorded in leadership team meeting notes can be viewed in Table 16 below.

Table 16.

Advisory Board Meetings				
Meetings	**Year 2 (11-12)**	**Year 3 (12-13)**	**Year 4 (13-14)**	**Year 5 (14-15)**
Fall	10/2011	9/2012 11/2012	10/2013 12/2013	10/2014 12/2014
Spring	1/2012 5/2012	2/2013 5/2013	2/2014 5/2014	3/2015 5/2015

Findings

While teachers cherished the time to collaborate with colleagues to redesign curriculum and refine their practice, they experienced varied levels of support from teacher leaders in that process.

- Teacher leaders successfully used the Key Elements to design thoughtful professional learning for and with teachers. Many teachers viewed the Key Elements as a crucial form of support that guided their PBL curriculum redesign process.
- While teacher leaders brought expertise and experience specific to PBL to their work with teachers, they struggled at times to support their colleagues' content-specific needs, both as a group and individually, as they worked to design or implement PBL curriculum.
- Support for incorporating outside experts into the curriculum redesign process was problematic. Teachers expressed a need for more help connecting with experts but were provided little specific structure or support in that area.
- Working without clearly delineated roles and responsibilities both empowered and compromised teacher leaders.

The Key Elements as a Crucial Support for Teachers' PBL Work

One of the central roles of teacher leaders throughout the grant was to further define and support the implementation of the Key Elements of Problem Based Learning as a description of PBL pedagogy and practice. The Key Elements anchored their work with teachers who were designing and implementing PBL curriculum. Teacher leaders used the Key Elements to ground all professional learning experiences. As such, the Key Elements emerged as a central tool teacher leaders used to support teachers' work in and out of the classroom.

While a majority of teachers described the Key Elements as a valuable tool for their ongoing professional growth, some dismissed them as either too simplistic or too general in scope. A World Language teacher described how they provide teachers with a "common language." A Social Studies teacher expressed a similar opinion stating, "It gives a framework and it gives a way to talk to each other." A Performing Arts teacher described how the Key Elements "made me reflect on my teaching. I kind of turned it [teaching] back on myself with each of the Key Elements." Those teachers that were dismissive of the Key Elements described them either as more superficial than insightful, as "things [that] are like basic good teaching" or as lacking some of the "content specific ways of thinking about things." These teachers' dissenting views represented a minority of teachers we interviewed.

Teachers voiced appreciation for how teachers and teacher leaders used the Key Elements to design relevant and thoughtful professional learning experiences. A teacher leader described them as a

"teaching improvement system" that guided teacher leaders' "thinking about teachers and developing them [the Key Elements] to create a learning environment that's conducive to all students. I mean what a great place to start." A new teacher to Sammamish recalled their first experience attending the Sammamish Institute for Teaching and Learning (SILT) and how different it was than other professional development they had experienced. They said, "I left just like jumping up and down because I had never sat in a PD where people were asking questions about things. About students and about learning, and sharing ideas and being excited about anything. I mean it was just totally different. I was so excited to get started."

Supporting Content-Specific Curriculum Design

Teacher leaders struggled to provide both more general, big picture support for PBL design and content-specific support teachers needed to make PBL work within the constraints of their discipline. Teachers were provided the Key Elements document to guide their thinking about PBL pedagogy but were provided few content-specific examples to draw from. This was by design. Teacher leaders and the principal wanted teachers to engage the curriculum design process creatively and expansively and to design curriculum that worked best for the specific students they served. While some teachers saw this as an exciting challenge, others found it frustrating and counter-productive.

Teacher leaders worked to support teachers' PBL curriculum design regardless of content-area constraints. This proved problematic for the teacher leaders and teachers. As one Math teacher stated, "I think the thing that kind of frustrating me the most is people who are running this whole thing trying to tell us how to do it when they've never taught a single math lesson in their life." Although shared by other teachers, this concern does not seem to be universally shared throughout the staff. Many teachers saw the lack of content-specific support as an authentic problem in an of itself that demanded they creatively and collaboratively problem solve in design teams. As a Science teacher stated, "Having a lack of PBL curriculum and examples I think in some ways is a challenge, I mean just like with teaching, having a model to look at, is helpful, um but I also think if you are looking for a PBL curriculum you are looking for a technical solution to an adaptive problem." A teacher leader corroborated this perspective saying, "If we are just keep giving them all these sample units, we're not actually getting the change that we want. So from that lens like I don't think that [not having PBL curriculum] was a problem." While teacher leaders worked to support all teachers as much as possible, they simply did not have the content knowledge to provide the support some teachers needed. This tension remained both a practical and philosophical conflict throughout the duration of the grant.

Using Outside Expertise for PBL Curriculum Design

Contacting, partnering, and leveraging outside experts proved problematic throughout the duration of the grant. While both teachers and teacher leaders acknowledged this as a problem early on in the PBL work, a good solution remained illusive. Teachers were concerned about the lack of experts available to them to contact and how to best use their expertise when they brought them into the curriculum design process. While a few individual teachers fostered productive relationships with outside experts, the process proved too overwhelming and ambiguous for many teachers. Teacher leaders also expressed frustration with their lack of expertise and experience in this area and thus with their limited ability to support teachers.

Many teachers were blunt in expressing their disappointment with the lack of support regarding experts in the classroom. A Math teacher stated, "Outside expertise has been impossible. We've just been making up what we could on our own." An English teacher shared this sentiment saying,

> I've been really, really, really disappointed by the focus that was given to us on how we should be involving outside experts. We were on our own, essentially, to locate those people, provide them, schedule them, bring them in. And then at the tail end of that, we were also expected to share those people's names with a person for collection and entry into a database. Um, and I think that a lot of us felt like we had traded on personal relationships with people.

Other teachers offered more nuanced assessments of what went wrong with the process saying,

> They [leadership team] had a teacher leader looking for experts for other disciplines, but she didn't have any contacts in our world, and it was, and then in certain languages, certain subjects it's harder to find the experts. So, so we didn't have the background research or the background experts to come in. And we didn't have the expertise to help with our PBL. So, you know that was kind of where we were lacking.

Although this was clearly a point of weakness in the support provided teachers, this task constituted new work for everyone involved. While some teachers likely had experience working with outside experts in their own classrooms or extra-curricular activities, very few models exist for how to locate and thoughtfully integrate experts into the curriculum planning and implementation process. Although teachers have great facility with the content they teach, teachers may not have much contact with professionals and outside experts who work in the fields and professions who use the content in their work. For example, a Biology teacher may or may not have Biologists friends or acquaintances to tap as external experts. The assumption that teachers would have vast networks of professionals who do work in the same content area in which teachers teach, further complicated efforts to connect teachers with outside experts.

Teacher Leaders as Empowered and Compromised Agents of Change

The Sammamish High School principal greatly empowered the teacher leaders to design and lead all professional learning experiences and support the PBL design and implementation process. He afforded the teacher leaders with latitude to define their roles and responsibilities and support teachers' work in ways that best matched their skills, talents, and strengths. Throughout the five years of the grant funded PBL work, the membership of the leadership team remained largely consistent. As teacher leaders continued to deepen and broaden their leadership and pedagogical expertise, they reinvested that expertise back into their work with teachers. Over time, the leadership team, consisting of the teacher leaders and the principal, developed a common vision for they should continue to support teachers and efficient and effective ways of working together. Much of the success of the PBL project can be attributed to the care and support the teacher leaders provided to teachers as they worked to design and refine their PBL courses.

Over time, however, there emerged resentment amongst some teachers that decision-making and power consolidated within the teacher leader ranks. One teacher stated, "I think there has been a growing feeling about just a core few group of people is making decisions. Um, and I think there was some resentment building about that as though it's like sort of this inner circle." Teacher leaders were funded

through the grant to be released from their typical teaching responsibilities. While this made sense from a school leadership perspective, some teachers increasingly found this policy to be problematic. Some teachers pointed out that they had more experience and expertise planning and teaching PBL, at least that which is articulated in the Key Elements, than the teacher leaders who were responsible for supporting and guiding their work. Lastly, some teachers questioned how the teacher leaders were held accountable and what their specific roles and responsibilities were. One teacher argued, "I don't see the leadership roles as effective at all. I think they are extremely ill-defined. I think that there, well, there isn't a job description, thusly there is no set of accountability measures to be taken that, one, these people are doing their job, or [two] that their job is necessary, or [three] that it is effective."

To be fair, these sentiments, although deepening amongst some teachers, were not universal. Some teachers expressed gratitude towards the teacher leaders and the work they had to help move the school towards PBL. While noting that greater transparency about specific teacher leader roles and responsibilities and how they were held accountable would have been welcomed, a teacher stated, "All that being said, I think they have done a hell of a job, I think that by and large the school respects them tremendously and is incredibly grateful to them, I know that I am. I have respect for every single one of those people and I, and I know how hard they have worked." Many teachers we spoke to described both a candid assessment of the drawbacks of a teacher leadership role and a deep respect for the work teacher leaders had accomplished.

For their part, many of the teacher leaders were not unaware of growing discontent towards them. One of the first teacher leaders to be promoted spoke in thoughtful ways about the role and how difficult it is to balance leadership responsibilities with existing relationships with colleagues. She said,

> Yeah I think, I mean I would add one thing. I think the, um, the innovation of doing, of changing instruction significantly within a traditional comprehensive high school, um, knowing how to do that means knowing how to make change amidst turnover, and amidst personalities of 65, 70 different staff. And amidst the, you know, power differentials within departments. And amidst people being people and leaders having their own specific styles that work with some people and don't work as well with some people, and knowing that all those constraints. I think our challenge, and the win of this grant, if it comes to fruition in that way, is knowing how do you make significant change? And you are gonna have people come and go, and you are gonna have people who work better or worse with other people. And you are gonna have, even whoever you put in leadership positions is gonna have, even if they are teacher leaders, they are gonna have specific styles. And they are gonna have limitations and they are gonna have personal lives. And they are gonna have, you know, um. And so it's about making change within that structure which, um, has not happened perfectly here. But I think has happened in some powerful ways, but, and I would say too that in some instances people who sound negative in an interview around PBL have actually shifted the practice in the classroom in ways that don't come across in an interview.

Speaking in the final year of the grant, this teacher leader reflected on the importance of the interpersonal dynamic of school leadership and how making change is a deeply personal and intimate endeavor. The

process of changing how people teach, how they see themselves as teachers and teacher learners, and how they interact with students is a long, difficult, yet not impossible process.

Discussion

While most of our analysis has been about the role of the teacher leader, we want to highlight several key components to success and struggles the leadership team faced throughout the duration of the grant. First, the distributed leadership approach taken by the principal was an integral and central underlying philosophy behind his decision-making. Eschewing a top-down approach to guiding the process of PBL design and implementation, he established the teacher leader core and engaged them as collaborators and equal decision makers. He empowered them to redesign the way professional learning experiences were developed and made those teachers the school's primary source of support and expertise. Second, although we describe the formal role of teacher leader within the school, many informal teacher leaders emerged since the beginning of the PBL project. Teachers have presented curriculum at national conferences, have served as guest speakers and teachers in university teacher education programs, and have taken up leadership positions within the district. Sammamish teachers have taken advantage of the flexibility they have been afforded to express leadership in myriad ways within and without the school. Third, many of the problems that have surfaced as a result of teacher leaders' work have more to do with the social, political, emotional inner-workings of public schools than any specific policy failure. Teacher leadership policies are problematic not just logistically but socially and interpersonally. Teaching is a profession built upon a strong egalitarian ethos. Promoting teachers within a school to a position of power and influence over other teachers creates interpersonal dilemmas both for the teachers who do not become teacher leaders and those that do. Lastly, not only were school leaders and teacher leaders flying blind, or as they would put it, "flying the plane while building it," but much of the work they were doing was unprecedented in public schools. Few public schools have attempted to transform themselves from a traditional school to a PBL school by drawing from existing teachers' expertise.

Chapter 6: Exploratory Studies 1 and 2
Assessing the Impact of Problem Based Learning (PBL) on Students' Career and College Readiness

In this section we share findings from two Exploratory Studies intended to identify possible components that impacted student growth and learning. In the first study we explore if any differences that exist in student performance on AP tests. We compare a group of students who took AP tests prior to the school's PBL adoption with a group of students who took AP tests while the school was implementing PBL across content areas. In the second study we explore the impact of the school's summer Sammamish Leads (formerly Starting Strong) program meant to introduce incoming students to PBL and to enrich current students' PBL skills by engaging them in relevant and authentic challenge cycles with industry experts.

We organize our findings using the following structure. First, we provide background to both studies by revisiting the school's stated goals in their i3 grant proposal and the demographic background about the students who have attended SHS over the past ten years. Second, we provide methodological background to how we collected, organized, and analyzed the quantitative data. Third, we share findings from Exploratory Study #1 in which we analyze longitudinal data comparing student performance on AP tests prior to and during the school's adoption of PBL and differences in AP pass rates over time. Specifically, we share findings from data collected at the school, course, and department level. This data includes a comparison of all students selected for inclusion in matched groups and subsets of those students who receive free and reduced lunch (FRL) services, students who receive Special Education accommodations or students with disabilities (SWD), and students who speak a first language other than English at home (EngNotFirst). Fourth, we share findings from Exploratory Study #2 in which we assess the extent to which student participation in Starting Strong/Sammamish Leads impacted participating students' future performance on the Campus Ready instrument. Finally, we discuss what these findings mean in the context of the school as we have observed it in the duration of our study.

As an i3 development project, the major evaluation goal was to provide data that project leaders could utilize to define, refine, and improve the project. This resulted in an updated logic model and fidelity of implementation criteria in which we articulate the essential components of the project. This, then, enabled the evaluation team to design and answer 3 research questions. Each of these questions was aimed to identify potential impacts that could be investigated using rigorous research techniques as a validation project in the future. The findings from these investigations illuminate relationships between project components and outcomes related to student college and career readiness.

The research questions we address in Exploratory Study #1 are as follows:

Question 1: AP Test Performance. Is there a relationship between student participation in courses that were targeted for PBL redesign and college and career readiness as defined by student performance on AP Tests (mean AP scores)?

Question 2: AP Pass Rates. Is there a relationship between student participation in courses that were targeted for PBL redesign and college and career readiness as defined by student performance on AP Tests (pass rates)?

The research question we address in Exploratory Study #2 is as follows:

Question 3: Starting Strong. Is there a relationship between student participation in Starting Strong/Sammamish Leads and college readiness as measured by student performance on the Campus Ready instrument?

Stated Goals and Student Populations

The stated outcome goals for the Sammamish High School i3 Development grant are as follows:

- 20% increase in AP pass rates, especially in STEM content areas (Biology, Chemistry, Statistics, Calculus AB/BC, Physics, Environmental Science),
- 20% increase in students with disabilities (SWD) and limited English proficient students (LEPS) enrolling in AP STEM classes,
- 75% of all students, 50% of SWDs, and 60% of LEPS successfully completing pre-calculus with a B or better,
- 100% of all students reaching standard on the state math test,
- 10% annual improvement on the state science test for all students,
- 15% annual improvement for SWDs and LEPs,
- 90% on-time graduation rate for SWDs and 75% on-time graduation for LEPS.

Although the school's grant proposal explicitly references students' scores on state tests, we have chosen to compare students' performance on AP exams for several reasons. Educational research demonstrates a strong correlation between a student's grade point average (GPA) (Geiser, Santelices, 2007; Sawyer, 2013) and their ability to succeed in college, noting that GPA remains one of the best predictors of a student's success in college. Scholars have also found similar strong correlations between a student's engagement and achieved success in AP coursework and their ability to succeed in college (Dougherty, Mellor, Jian, 2005; Reid, Moore, 2008).

Conversely, educational researchers have yet to identify a strong correlation between a student's score on various state high stakes tests and their college readiness. This conundrum is especially pronounced in Washington State where since 2002, the state high stakes test has changed three times from the Washington Assessment of Student Learning (WASL) to the High School Proficiency Exam (HSPE) to the current Smarter Balanced Assessment (SBA), making longitudinal comparisons, using those measures, between groups of students nearly impossible.

These desired outcomes listed by the school were closely linked to the school's desire to improve students' college and career readiness and further open access to rigorous science, technology, engineering, and mathematics (STEM) coursework to more students through the use of problem based learning in all core content coursework. To address the research questions stated above, we assembled a large database of student variables.

PBL Redesigned Courses, Student Cohorts, and Student Populations

One of the major goals of the i3 project was to redesign a significant portion of the courses offered into PBL courses. The following is a list of the courses that were targeted for redesign (i.e., had a teacher design team work on the redesign) and their corresponding year of implementation. Note that

these courses are labeled as 'targets.' Whether or not PBL was implemented is not reflected in this list. Of these courses, 13 had an Advanced Placement designation.

Table 17 shows the courses that were targeted for PB redesign and the year in which they were redesigned.

Table 17.

Courses Targeted for PBL Redesign	
Targeted Courses	**School Year of Implementation**
AP BIOLOGY	12
ALGEBRA 2	12
AMER LIT/COMP	13
AP AM STUDIES	14
AP AM/COMP GOV	14
AP AMER GOVT	10
AP CHEMISTRY	13
AP CHINESE LANG	12
AP ENV SCI	10
AP HUMAN GEOG	11
AP PHYSICS 1	14
AP SPANISH LANG	13
AP US HIST/LNG/CMP	14
AP US HIST	13
AP WORLD HIST	12
BIO/CHEM 1	12
BIO/CHEM 2	12
BIO/CHEM I & II	11
CHINESE 3	12
CHORALE CHOIR	12
CONCERT BAND	12
CONCERT CHOIR	12
CORE PHYS ED 1	12
CORE PHYS ED 2	12
DIG VID/AUDIO 1	11
DIG VID/AUDIO 2	11
DIG VIDEO/AUDIO	11
DRAMA	12
ELL AMER LIT	12
FRENCH 3	13
GEOMETRY	13
HEALTH	12
HLTH SCI CAREER	12
HON FROSH COMP	12
HON SOPH COMP	12
INTRO COMP PROG	11
ORCHESTRA	12
PHYSICS	13

PRE-CALCULUS	14
SPANISH 4	13
US HISTORY	13
WORLD HISTORY	12

Rather than graduation year, in this report we refer to each group of students as a Cohort defined by the school year in which students were or would have been freshmen. Table 18 below provides a key for Cohort and Graduation years, as well as the total number of students in each cohort.

Table 18. Cohort Names, Graduation Year, and Number of Students

Cohort	Graduation Year	Number of Students
C 2002	2006	361
C 2003	2007	419
C 2004	2008	391
C 2005	2009	417
C 2006	2010	364
C 2007	2011	347
C 2008	2012	360
C 2009	2013	347
C 2010	2014	361
C 2011	2015	371
C 2012	2016	324
C 2013	2017	282
C 2014	2018	207

Table 19 below presents each cohort and its related dosage with respect to the years the project was being developed and implemented. Because of the way redesigned PBL courses were phased in over time it is important to clearly understand which students received which courses and how many courses each student took.

Table 19.

Comparison of Mean Number PBL and All Courses Taken by Cohort			
Cohort	**Mean Number of PBL Targeted Courses**	**Mean Number of all courses taken**	**Percent**
Cohort 2	0	22	0%
Cohort 3	0	21	0%
Cohort 4	0	24	0%
Cohort 5	0	26	0%
Cohort 6	0	28	0%
Cohort 7	1	30	3%
Cohort 8	2	31	5%
Cohort 9	2	30	8%
Cohort 10	5	30	16%
Cohort 11	20	30	66%

Some students in Cohort 2007, who began their time at SHS 3 years before the project was initiated, had access to the first PBL courses designed as a sort of pilot to this project. Conversely, many students that began as Freshmen during the project did not have opportunities to take the upper level redesigned courses that came online after they had graduated. Two cohorts in particular had four full years in the project but their doses were considerably different. Cohort 2010 was essentially one year ahead of much of course implementation and as such is more similar to a partial dose cohort. Cohort 2011 is the first cohort that received a 'near' full dose of the redesigned curriculum although the courses were in the first year of implementation, in many cases.

It is helpful to visualize the points in time relative to project years that each cohort was receiving the SHS curricular dose. Table 20 below presents each cohort crossed with each school year. There are 3 basic levels of dosage of the i3-sponsored curriculum that students receive: No dose, partial dose, and full dose. Because of the staggered approach to course implementation the partial doses contain a range of intensities. Cohort 2011-12 was the first cohort to receive a near full dose and for which 4 years of data is available. Cohort 2012-13 was the first cohort to receive the full dose access to all redesigned courses but only data through their junior year (2015) is available.

Table 20.

	Cohort 2002-03	Cohort 2003-04	Cohort 2004-05	Cohort 2005-06	Cohort 2006-07	Cohort 2007-08	Cohort 2008-09	Cohort 2009-10	Cohort 2010-11	Cohort 2011-12	Cohort 2012-13	Cohort 2013-14	Cohort2014-15
SY 2002-03	FR												
SY 2003-04	SO	FR											
SY 2004-05	JR	SO	FR										
SY 2005-06	SR	JR	SO	FR									
SY 2006-07		SR	JR	SO	FR								
SY 2007-08			SR	JR	SO	FR							
SY 2008-09				SR	JR	SO	FR						
SY 2009-10					SR	JR	SO	FR					
SY 2010-11						SR	JR	SO	FR				
SY 2001-12							SR	JR	SO	FR			
SY 2012-13								SR	JR	SO	FR		
SY 2013-14									SR	JR	SO	FR	
SY2014-15										SR	JR	SO	FR
	No Dose					Partial Dose			Partial Dose -Pre Course Redesign	Full Dose -Pre Course Redesign	Full Dose Fr-Jr	Full Dose Fr-So	Full Dose Fr

How We Describe Groups of Students

The evaluation team grouped subsets of students according to whether or not they receive free and reduced lunch (FRL) services, whether or not they have disabilities (SWD), and whether or not they speak a first language other than English at home. We provide rationale below for why we grouped students according to those categories in our analysis.

*Free and reduced lunch (FRL**).*** One of the ways we disaggregate student performance data is by whether or not students receive free and reduced lunch services. Although typically under-representative of the number of students living in poverty, a school's FRL statistic is commonly used by the Department of Education and other state government entities as the poverty index for a school. For example, a school does not qualify for Title I funds until 40% of their students receive free and reduced lunch support. Many educational researchers point to poverty as the single most entrenched problem facing public schools in the U.S (Darling-Hammond, 2010; Berliner, 2013). Their research indicates that a student's socio-economic status can be a reliable predictor of a student's performance on standardized test scores and overall performance in school, in many cases regardless of the race of the student (Sirin, 2005).
We do not disaggregate the performance data by race for two reasons. First, the way the federal, state, and district entities collect data on students' racial demographics is lacking. Students from the Middle East, for example, would have to identify themselves as African American, Hispanic, Native American, Multi-racial, White, or Other. These narrow categorizations would be confusing for parents and families and may lead to imprecise data based solely on racial classifications. Second, although such factors as parental

educational background, race, ESL, and gender plays a role, a student's SES status most significantly impacts the extent to which students can overcome those variables to access rigorous coursework that makes them more college ready (Cabrera, La Nassa, 2000; Berliner, 2013). In the cases where students have low SES status, the variables of race, ESL, at times gender, can further complicate their ability to access rigorous coursework and succeed in school. In the cases where students have middle to high SES status, those variables can be easier for students to overcome (Cabrera, La Nassa, 2000).

Students who speak a language other than English at home (EngFirst). Another way we disaggregate the data is to track students' AP scores who speak a language other than English at home. Although this is not a perfect measure of a student's proficiency with English, it does provide some indication of whether or not the English language remains a barrier to their learning in school. We do not use the standard classification of English Language Learner (ELL) or Limited English Proficiency (LEP) students to categorize students for the following reasons. First, we have found that categorizations of courses as ELL or LEP are not consistent from year to year. Second, the state exam used to classify students as ELL students has shifted several times since 2002, making an apples-to-apples comparison of ELL students' AP scores between years problematic. Instead, we use the more stable and reliable self-reported statistic of students who report to speak a language other than English at home. A good example of this can be found in Table 3 below that illustrates the striking difference between students who received ELL services and those who self-identified as speaking a language other than English at home. These data suggest that the range of language proficiency at Sammamish may be far wider than represented solely by the number of students who receive ELL services.

Students with Disabilities (SWD). We use this phrase to describe students who receive Special Education accommodations as documented in a 504 Plan or Individualized Education Plan (IEP). These students may or may not be in a pull out Special Education class.

Table 21 illustrates the demographic changes Sammamish High School experienced from 2002 to 2011. Of note is the increase in students with disabilities (SWD) and increase, since 2006, in students who speak a language other than English at home and students who receive free and reduced lunch (FRL) services.

Table 21.

	SWD	ELL	FRL	English Not Language at Home
Cohort 2	10%	5%	30%	30%
Cohort 3	14%	4%	26%	26%
Cohort 4	11%	5%	28%	28%
Cohort 5	12%	3%	26%	26%
Cohort 6	18%	3%	25%	25%
Cohort 7	16%	6%	34%	34%
Cohort 8	21%	5%	35%	35%
Cohort 9	23%	9%	38%	38%
Cohort 10	25%	8%	36%	36%
Cohort 11	23%	9%	34%	34%

Methodology: Exploratory Study #1

In this study, we compared AP Test Scores of two groups: those students that had participated in at least one targeted PBL redesigned course and those that had not. The former group (Treatment) received varying dosages of the redesigned curriculum depending on when they were enrolled at SHS. The comparison group received no dosage. Students were drawn from school data as early as 2001 and as late as the 2014-15 school year.

Matching

A matched comparison group, pre-post design was used to answer questions about the impact of project implementation on AP Test performance. Two groups, treatment and comparison, were established based on student exposure to courses that were targeted for redesign by the i3 project. Treatment students had taken at least one targeted PBL course while comparison students had not taken a targeted PBL course. For the analysis a variable called "PBLPool" was created and coded with a 0 for the comparison group and 1 for the treatment group.

A decision was made to include students from cohorts 5 through 12 in the pool because (1) the number of years prior to the innovation was about the same as the project period, (2) full Free/Reduced Lunch data (a key covariate in our data analysis) was not available for earlier cohorts, and (3) these cohorts were temporally adjacent to each other which helped control for environmental and cultural differences experienced by these two groups. Next, all AP Test taker data from this time period was compiled into a single database in which the unique record identifier consisted of 2 variables: student ID and AP Test. Only the first attempt at each AP Test was utilized in the database to reduce re-testing effects. (A small percentage of students, less than 5%, typically retake AP exams.)

Students were then matched on AP Tests taken and the number of years they spent at SHS. Demographic covariates (SWD, English First, FRL, and gender) along with overall high school GPA were used as covariates in the statistical analysis. We then selected only those students that had taken AP tests in English, Math, Science, and Social Studies. While we don't discount the importance of AP tests in the Arts and World Languages, data from these areas was spotty and inconsistent over time making the longitudinal analysis difficult.

After matching was completed we looked for systematic differences between matched and unmatched AP test takers, as well as between AP Test takers and non-AP Test takers. The analysis revealed the following: The proportion of students with category labels SWD, ELL, FRL, and EngNotFirst is much greater in the non-AP Test takers group than in the AP Test takers group. Chart 1 below illustrates the differences in percentages between students who took no AP courses, students who were not matched by took an AP course, and students who were matched and took an AP course. We compared the differences between these three groups according to the demographic subsets of students: ELL, SWD, EngNotFirst, and FRL. Chart 1 shows that students from those subsets disproportionally make up the percentage of non-AP students. However, since 2005, enrollment of SWDs and EngNotFirst students in AP courses has increased. Chart 2 below illustrates the raw number of SWD and EngNotFirst students who took an AP Test for each of the cohorts.

To explore whether project implantation had an impact on the non-AP group we discuss the results of a follow up analysis below.

Chart 1.

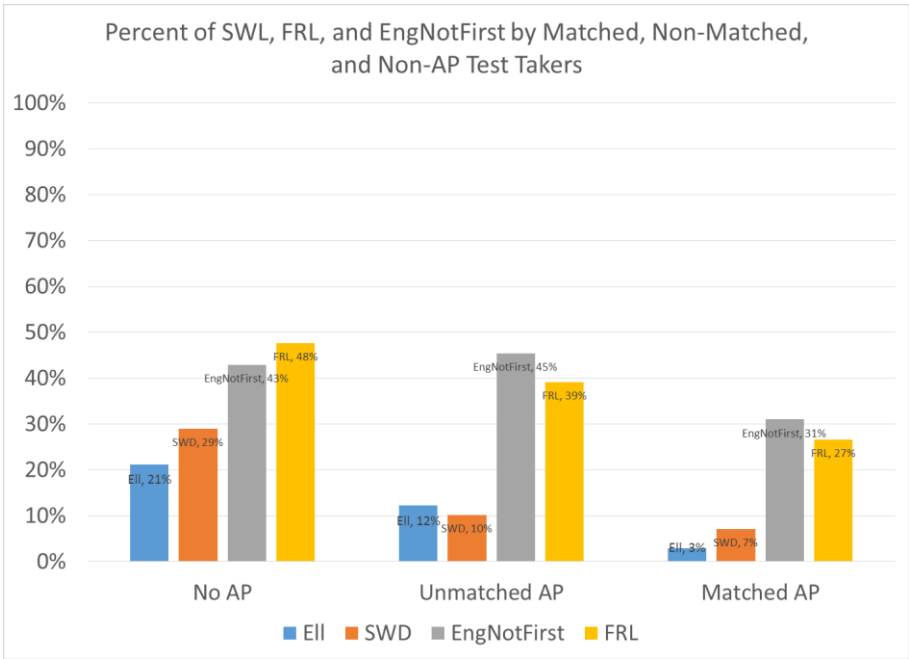

Percent of SWL, FRL, and EngNotFirst by Matched, Non-Matched, and Non-AP Test Takers
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Ell, 21%
SWD, 29%
EngNotFirst, 43%
FRL, 48%
Ell, 12%
SWD, 10%
EngNotFirst, 45%
FRL, 39%
Ell, 3%
SWD, 7%
EngNotFirst, 31%
FRL, 27%
No AP
Unmatched AP
Matched AP
Ell
SWD
EngNotFirst
FRL

Chart 2.

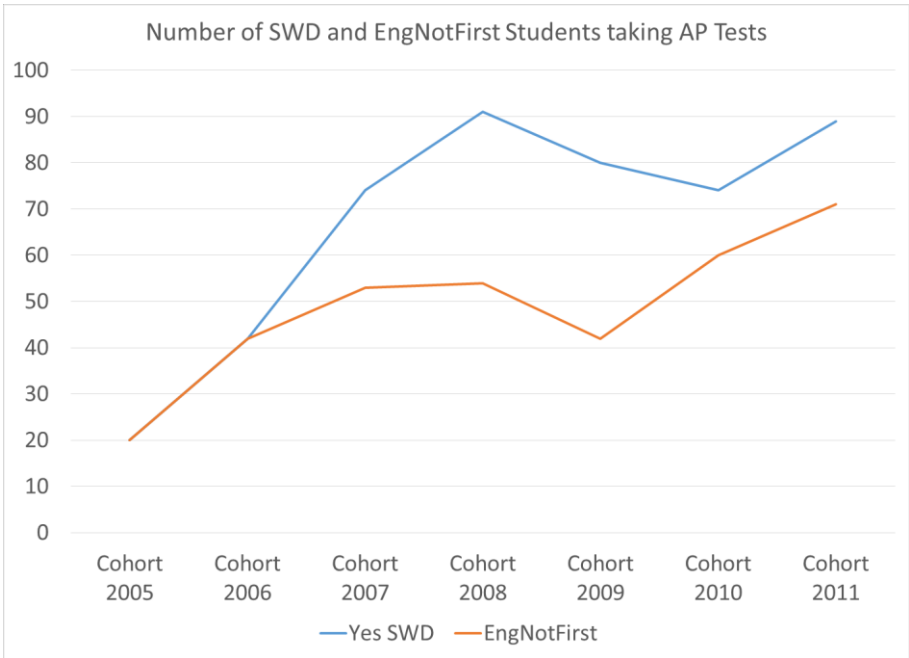


Table 22 presents the number of students in each cohort that were matched by the number of SHS years and AP Test. The total number of AP Tests taken by the Treatment Group was 3,505.

Table 22.

Number of Students in Each Cohort Matched by Number of SHS Years and AP Test								
	English		Math		Science		Social Studies	
	Comparison	**Treatment**	**Comparison**	**Treatment**	**Comparison**	**Treatment**	**Comparison**	**Treatment**
Cohort 2005	224	0	162	0	220	0	302	0
Cohort 2006	218	0	164	0	194	0	340	0
Cohort 2007	92	111	76	88	87	100	99	147
Cohort 2008	50	177	38	132	52	162	68	259
Cohort 2009	29	164	23	128	48	224	51	207
Cohort 2010	14	113	13	104	18	195	26	187
Cohort 2011	1	153	0	100	1	200	1	249
Cohort 2012	1	76	0	16	0	73	0	140
Totals	629	794	476	568	620	954	887	1189

In Table 23 below, we illustrate the number of AP Tests used in the analysis by each course. Several test versions were available for calculus and physics. For the analysis we pooled the numbers of students and their scores into single combined test groups taking their best score if they had more than one test in the pool. Overall there were 6117 AP Tests taken by 1462 students (treatment n = 810; comparison n = 652) for an average of 4.2 AP Tests taken per AP Test taker.

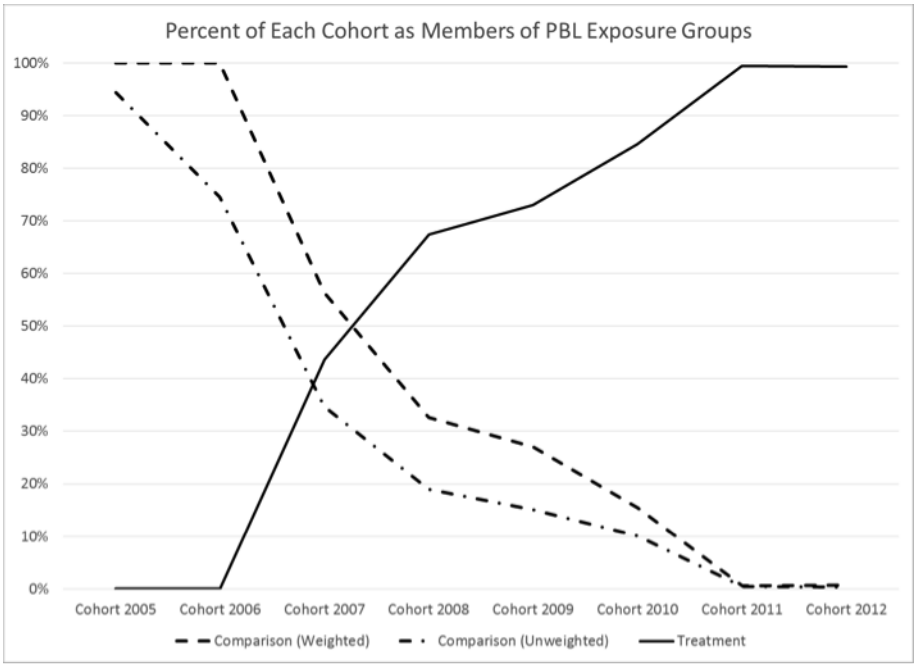
Table 23.

AP Tests Taken by Course			
	Comparison	Treatment	Total
Biology	218	355	573
Calculus (Combined)	268	360	628
Chemistry	118	198	316
English Language	388	497	885
English Literature	241	297	538
Environmental Science	225	342	567
U.S. Government	196	281	477
Physics (Combined)	59	59	118
Psychology	98	127	225
Statistics	208	208	416
U.S. History	263	293	556
World History	330	488	818
	2612	3505	6117

Assignment into either the treatment or comparison groups was determined by sorting students into 2 piles: those what had taken no courses that had been redesigned as part of project activities, and those that had taken at least one targeted PBL course. Students from Cohorts 2007 through 2012 were eligible for treatment group membership, while students form Cohorts 2005 and later were eligible for the comparison group.

The comparison group consisted of students from all cohorts but primarily from cohorts 2005 to 2010. Before matching, comparison students were sorted in descending order by cohort year while treatment students were sorted in ascending order. This allowed the matching algorithm to select matches (in case of ties) that were closest in time to project implementation. This helped to control for contextual variables such as teacher, curriculum, and content standards and also allowed for students to be matched to students in the same cohort. Even though there were more comparisons students in the pool, students in the treatment group had taken more AP courses than comparison students. Thus we allowed comparison students to be matched more than one student/AP test in the treatment group. We then assigned a valued representing the number of matches they were in and used that to weight the case in statistical calculations.

Chart 3.


Percent of Each Cohort as Members of PBL Exposure Groups
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Cohort 2005
Cohort 2006
Cohort 2007
Cohort 2008
Cohort 2009
Cohort 2010
Cohort 2011
Cohort 2012
Comparison (Weighted)
Comparison (Unweighted)
Treatment

Findings: Exploratory Study #1: Comparison of Student Performance in AP Coursework

In this section we share findings from Exploratory Study #1 in which we compared student performance on Advanced Placement (AP) tests using an interrupted time series analysis. We compared the mean AP test scores of students who took AP courses prior to the school's adoption of PBL with students who took AP courses during the school's ongoing implementation of PBL.

Overall, students in the treatment group outperformed their matched peers in the comparison group on multiple Advanced Placement (AP) tests. In some cases, student gains were statistically significant, even when data was disaggregated according to students who receive free and reduced lunch (FRL) and Special Education services (SWD) and students who speak a first language other than English at home (EngNotFirst).

Additionally, students in the treatment group overall have a higher percentage of AP tests passed than the comparison group despite more students taking AP courses and the associated AP tests over time. We also found a strong correlation between the number of PBL courses a student took and their mean AP score. As students took more PBL courses, their AP mean score increased. Within the treatment group, we also found a positive correlation between an increased number of PBL courses a student took and the percentage of AP tests they passed throughout their four years at Sammamish High School.

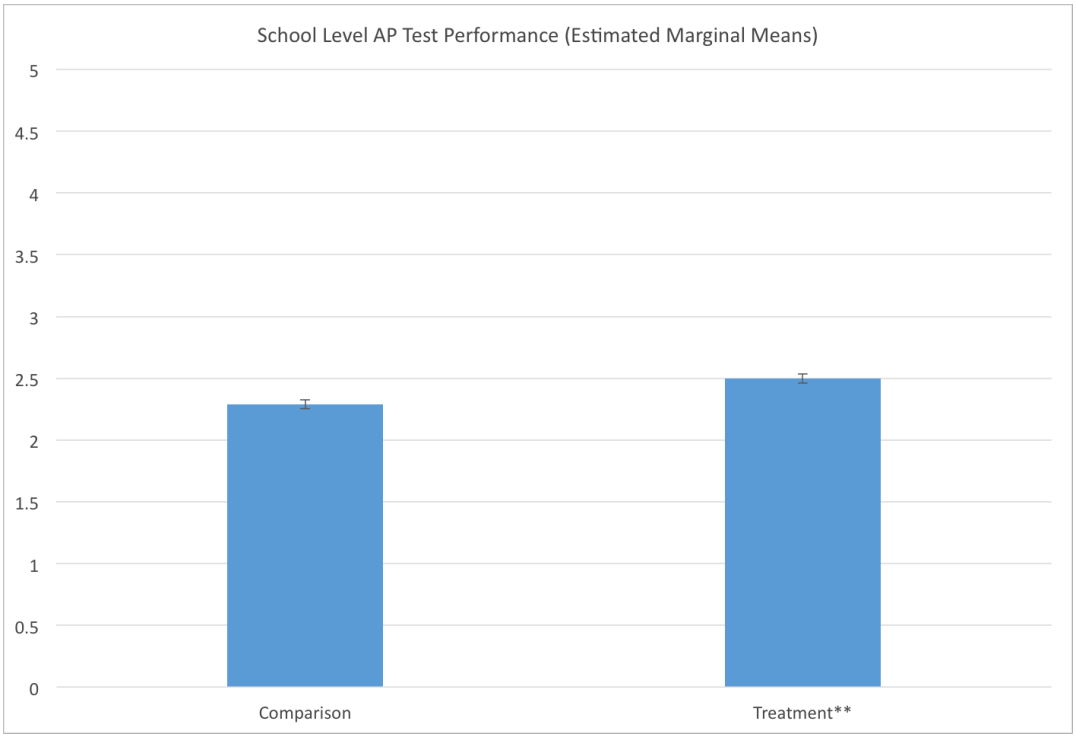
When aggregated to department-level performance on AP exams, students in the treatment group experienced gains in AP scores in the Math, English, Science, and Social Studies departments. In the Math, Science, and Social Studies departments, student gains in mean AP scores were statistically significant. The departments that experienced the highest gains in student AP scores were the departments that more fully adopted PBL. Upon closer analysis, the data suggest that departments interacted with the PBL initiative and the Key Elements differently. While not every department adopted PBL in the same way, those that used the Key Elements to guide ongoing curriculum design and redesign experienced the largest student gains in AP scores throughout the department.

In each of the following figures, we use a double asterisk (**) to denote statistically significant differences in mean AP scores. Also, we insert "error bars" to show the range beyond which gains were statistically significant. Error bars illustrate the extent of the variability within which gains fall within the standard error. The range illustrated by error bars can change dramatically depending on whether we are examining scores by department or course and they can also be different depending on course.

Rough Comparison of AP Score Means by Group

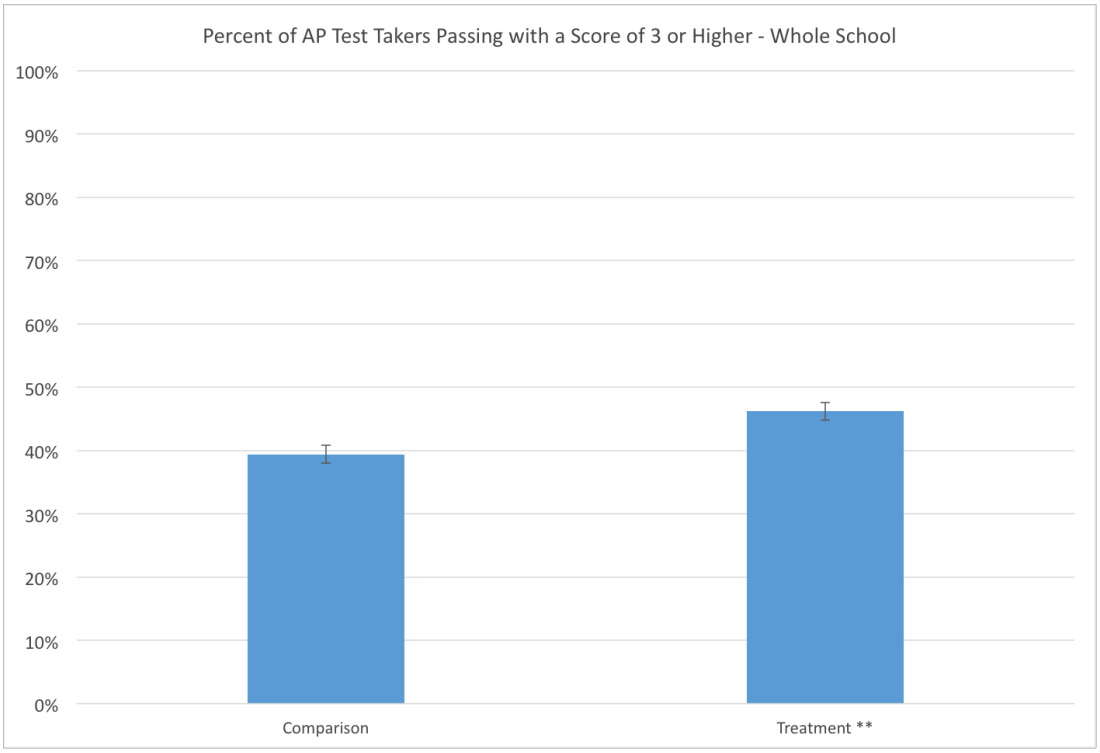
Chart 4 below illustrates the difference in AP score mean between the comparison and treatment cohorts. When aggregating all AP scores received by every student in the comparison and treatment group, students in the treatment group experienced a statistically significant increase (2.29 to 2.49) in mean scores on all the AP tests they took.

Chart 4.



In addition to an overall increase in AP score means, students also passed AP tests at a statistically significant higher rate across the school. Chart 5 illustrates the difference in AP test pass rates by students in the comparison and treatment groups.

Chart 5.



Comparison of Mean AP Scores by AP Course

Overall, students in the treatment group experienced gains on AP scores across multiple AP courses including: AP Biology, AP Calculus (combined BC and BCAB), AP Chemistry, AP English Language, AP English Literature, AP Environmental Science, AP United States Government, AP Physics (combined all levels of Physics), AP Psychology, AP Statistics, and AP World History. Student gains on AP scores were statistically significant in AP Biology, AP Calculus (combined BC and BCAB), AP Chemistry, AP United States Government, AP Psychology, AP United States History, and AP World History.

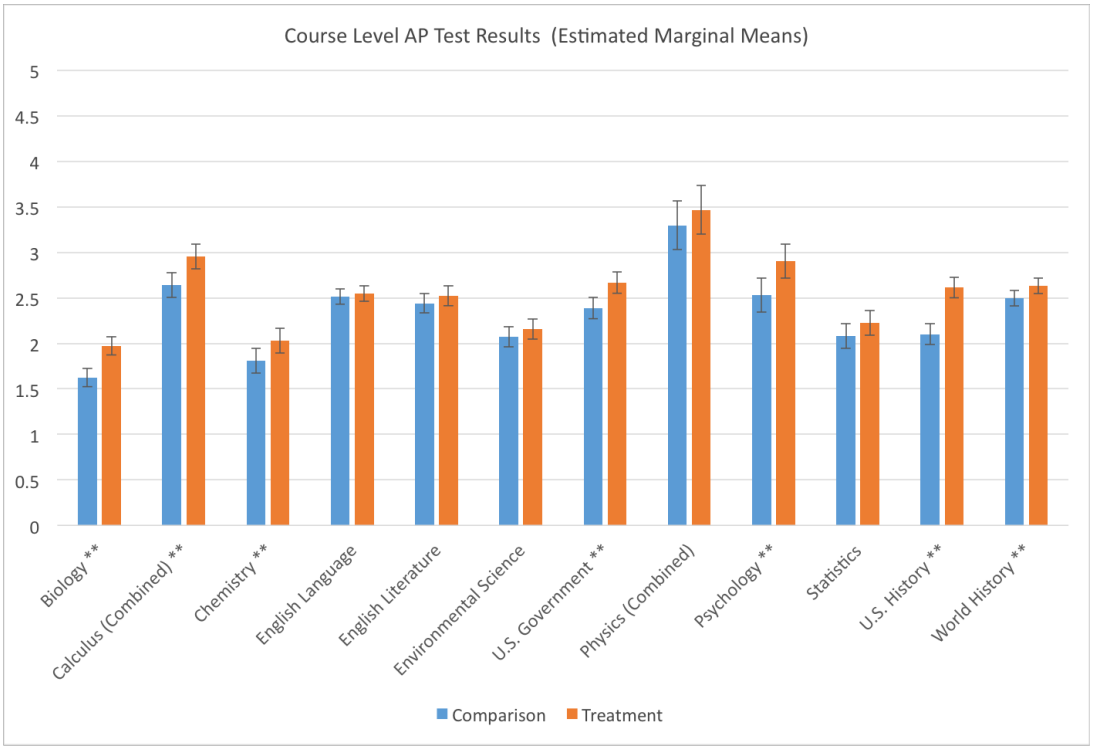
Table 24 below illustrates the mean AP score differences by course, between all students in the comparison and treatment groups.

Table 24.

Statistically Significant Gains in Mean AP Scores by Course	
Course	**Mean AP Score Difference**
AP Biology	1.62 to 1.97
AP Calculus (combined)	2.64 to 2.95
AP Chemistry	1.80 to 2.02
AP United States Government	2.38 to 2.66
AP Psychology	2.53 to 2.90
AP Unites States History	2.10 to 2.63
AP World History	2.49 to 2.63

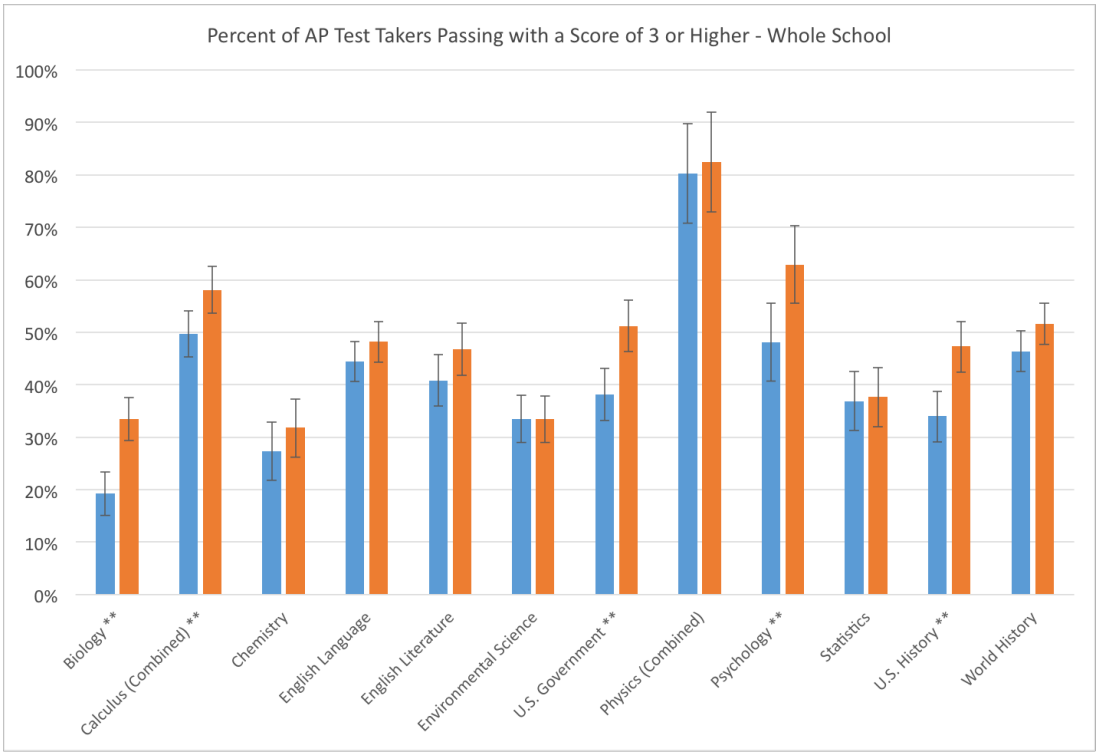
Chart 6 below illustrates the difference between the comparison and treatment groups in mean AP score by course. Amongst the courses listed below, only AP Biology, AP Chemistry, AP Physics, AP United States History, and AP World History were redesigned by funds from the i3 grant. However, all courses listed below were taught by teachers who had design team experience at some point during the i3 project.

Chart 6.



In addition to an increase in AP score means, students also passed AP tests at a higher rate across courses. Chart 7 illustrates the difference in AP test pass rates by course by students in the comparison and treatment groups. In AP Biology (19% to 33%), AP Calculus (combined) (50% to 58%), AP United States Government (38% to 51%), AP Psychology (48% to 63%), and AP United States History (34% to 47%), students in the treatment group passed at a statistically significant higher rate than students in the comparison group.

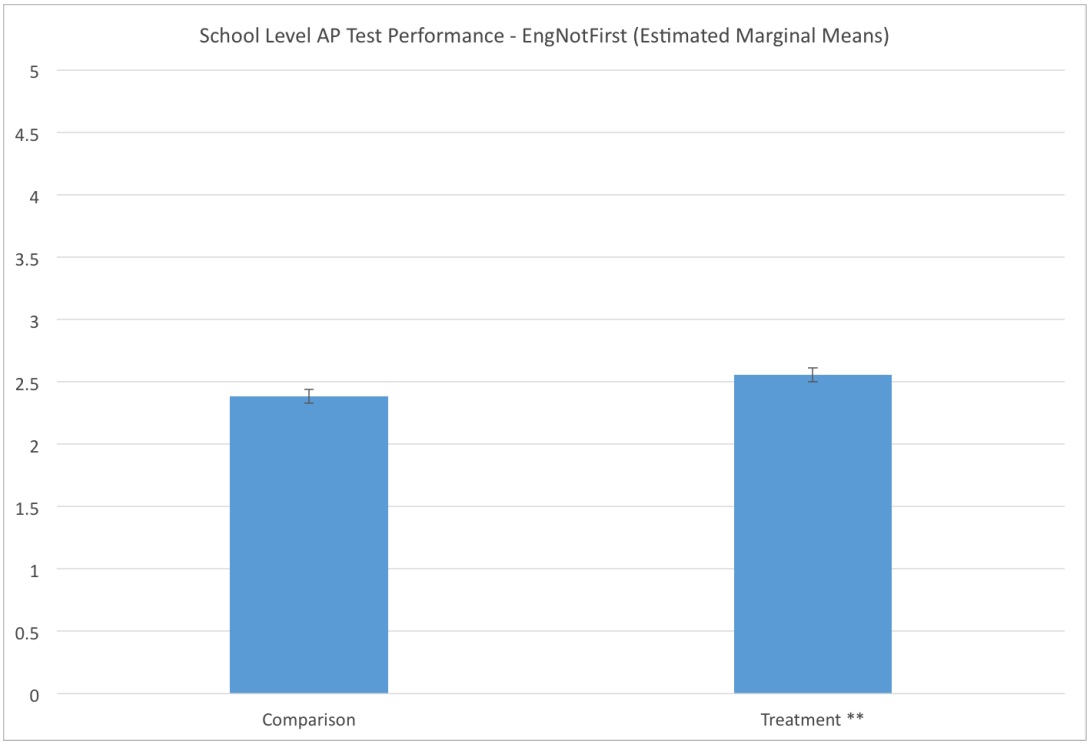
Chart 7.



Comparison of Mean AP Scores by Students Who Speak a First Language Other Than English at Home (EngFirst)

Chart 8 below illustrates the difference in mean AP score between students who speak a first language other than English at home in the comparison and treatment cohorts. When aggregating all AP scores received by those students in the comparison and treatment group, students in the treatment group experienced a statistically significant increase (2.38 to 2.55) in mean scores on all the AP tests they took.

Chart 8



Students in the treatment group who speak a first language other than English at home experienced gains in AP scores in the following AP courses: AP Biology, AP Chemistry, AP English Language, AP English Literature, AP Environmental Science, AP United States Government, AP Physics (combined all levels of Physics), AP Psychology, AP Statistics, and AP World History. Those students experienced statistically significant gains in AP Biology, AP United States Government, AP Psychology, and AP United States History.

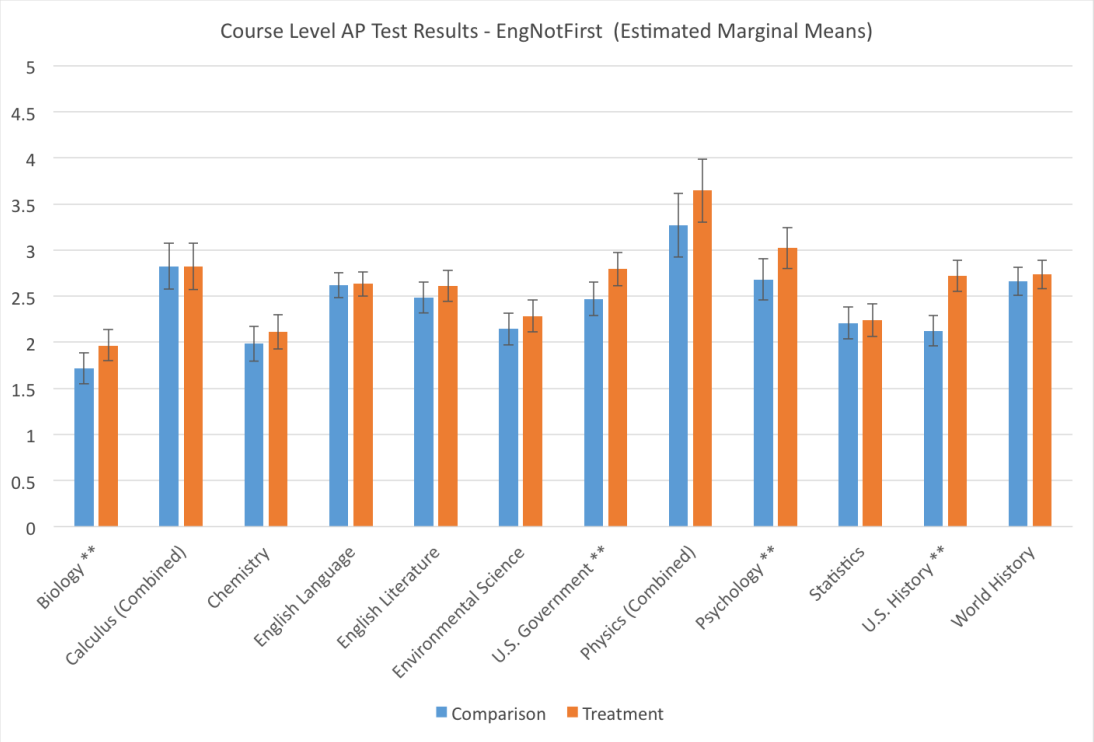
Table 25 below illustrates the mean AP score differences by course, between students who speak a first language other than English at home in the comparison and treatment groups.

Table 25.

Statistically Significant Gains by Students Who Speak a First Language Other Than English at Home (EngNotFirst) in Mean AP Scores by Course	
Course	**Mean AP Score Difference**
AP Biology	1.71 to 1.96
AP United States Government	2.47 to 2.79
AP Psychology	2.68 to 3.02
AP Unites States History	2.12 to 2.72

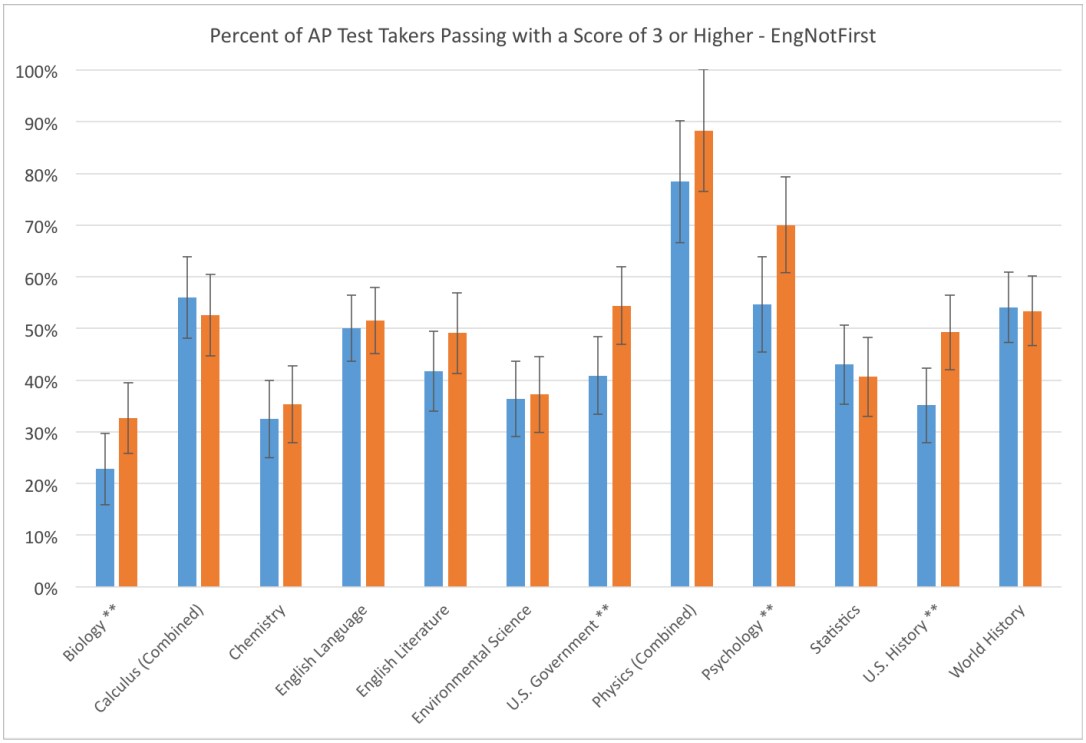
Chart 9 below illustrates the difference in AP Score means between students who reported to speak a first language other than English at home in the comparison and treatment groups.

Chart 9.



In addition to an increase in AP score means, students who speak a first language other than English at home also passed AP tests at a higher rate across courses. Chart 10 illustrates the difference in AP test pass rates by course by students in the comparison and treatment groups. In AP Biology (23% to 33%), AP United States Government (41% to 54%), AP Psychology (55% to 70%), AP United States History (35% to 49%), the percentage of EngNotFirst students in the treatment group who passed the AP test was statistically significant higher than the percentage of EngNotFirst students who passed the AP test in the comparison group. Of note are AP Calculus (combined), AP Statistics, and AP World History in which a lower percentage of EngNotFirst students in the treatment passed the AP test than their comparison group peers.

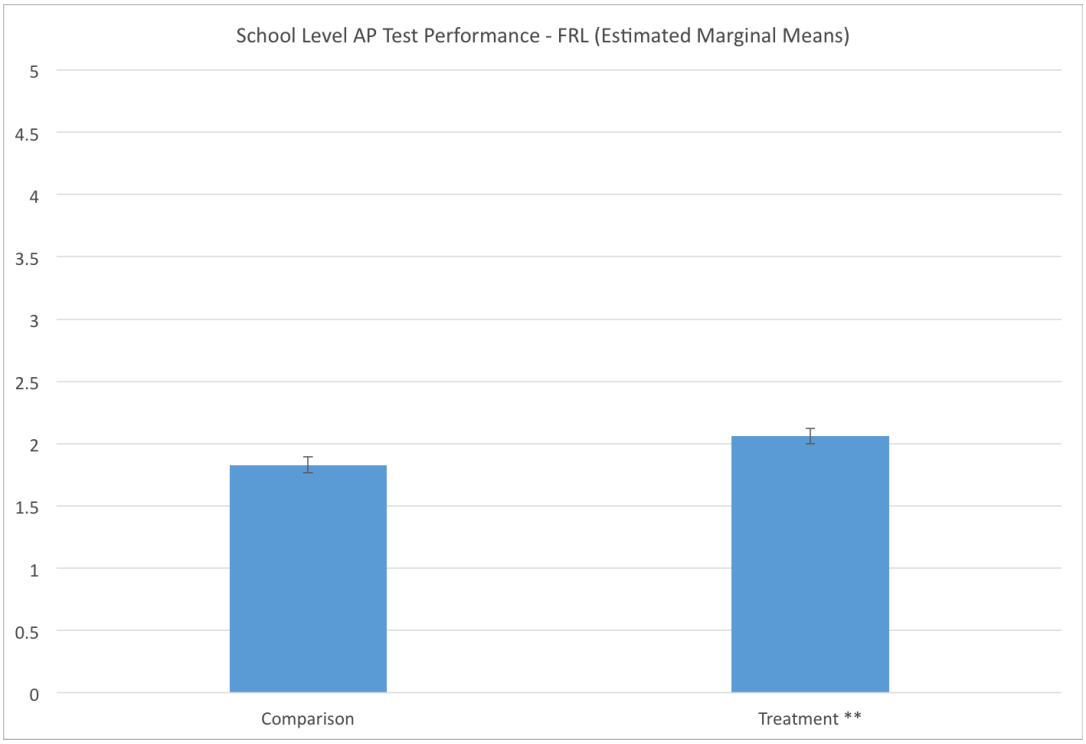
Chart 10.



Comparison of Mean AP Scores by Students Who Receive Free and Reduced Lunch (FRL) Services

Chart 11 below illustrates the difference in mean AP scores between students who receive free and reduced lunch (FRL) services in the comparison and treatment cohorts. When aggregating all AP scores received by those students in the comparison and treatment group, students in the treatment group experienced a statistically significant increase (1.82 to 2.06) in mean scores on all the AP tests they took.

Chart 11.



Students in the treatment group who qualify for free and reduced lunch (FRL) services experienced gains in AP scores in the following AP courses: AP Biology, AP Chemistry, AP Calculus (combined), AP English Language, AP English Literature, AP Environmental Science, AP United States Government, AP Psychology, AP Statistics, and AP World History. Those students experienced statistically significant gains in AP Biology, AP Environmental Science, and AP World History.

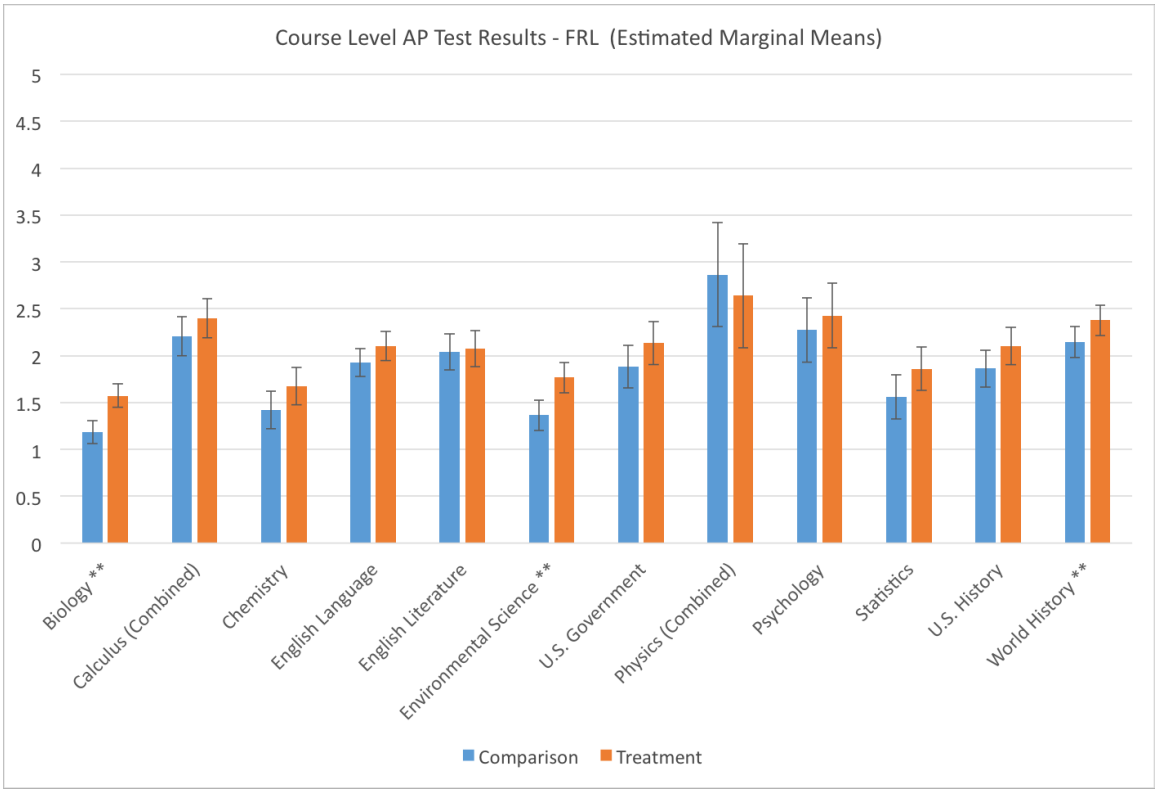
Table 26 below illustrates the mean AP score differences by course, between students who received free and reduced lunch (FRL) services in the comparison and treatment groups.

Table 26.

Statistically Significant Gains by Students Who Receive Free and Reduced Lunch (FRL) Services in Mean AP Scores by Course	
Course	**Mean AP Score Difference**
AP Biology	1.18 to 1.57
AP Environmental Science	1.36 to 1.76
AP World History	2.14 to 2.37

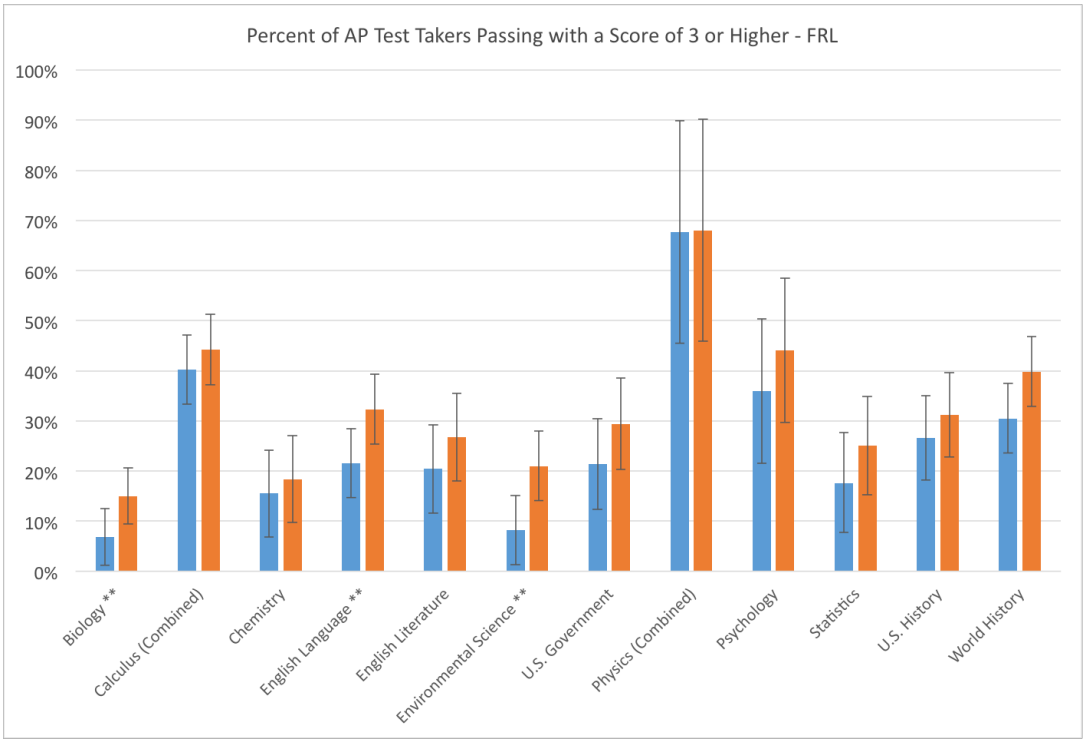
Chart 12 below illustrates the difference in AP Score means between students who received free and reduced lunch services in the comparison and treatment groups.

Chart 12.



In addition to an increase in AP score means, students who received free and reduced lunch (FRL) services also passed AP tests at a higher rate across courses. Chart 13 illustrates the difference in AP test pass rates by course by students in the comparison and treatment groups. In AP Biology (7% to 15%), AP English Language (22% to 32%), and AP Environmental Science (8% to 21%), the percentage of FRL students in the treatment group who passed the AP test was statistically significantly higher than the percentage of FRL students who passed the AP test in the comparison group.

Chart 13.



Comparison of Mean AP Scores by Students With Disabilities (SWD)

Chart 14 below illustrates the difference in AP score means between students with disabilities (SWD) in the comparison and treatment cohorts. When aggregating all AP scores received by SWDs in the comparison and treatment group, students in the treatment group (2.02) outperformed students in the comparison group (1.85). However, the gains experienced by these students in the treatment were not statistically significant.

Chart 14.

Students with disabilities (SWD) in the treatment group experienced gains in AP score means in the following AP courses: AP Biology, AP Calculus (combined BC and BCAB), AP English Literature, AP Psychology, AP Statistics, and AP United States History, and AP World History. Those students experience statistically significant gains on AP scores in AP Calculus (combined BC and BCAB), AP Statistics, AP Physics (combined all levels of Physics), and AP United States Government.

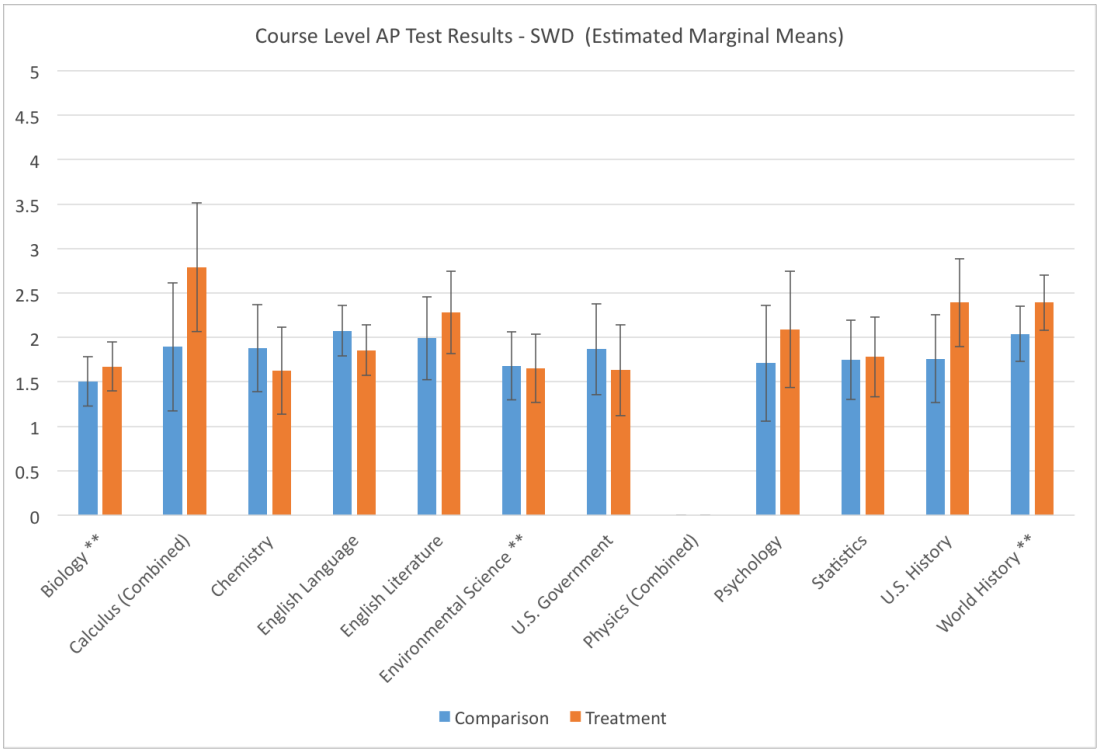
Table 27 below illustrates the mean AP score differences by course, between students with disabilities (SWD) in the comparison and treatment groups. Of note is performance of students with disabilities (SWD) in AP Environmental Science. In that course, students in the comparison group outperformed their peers in the treatment group by a statistically significant margin (1.68 to 1.65).

Table 27.

Statistically Significant Gains by Students with Disabilities (SWD) in Mean AP Scores by Course	
Course	**Mean AP Score Difference**
AP Biology	1.50 to 1.67
AP World History	2.04 to 2.39

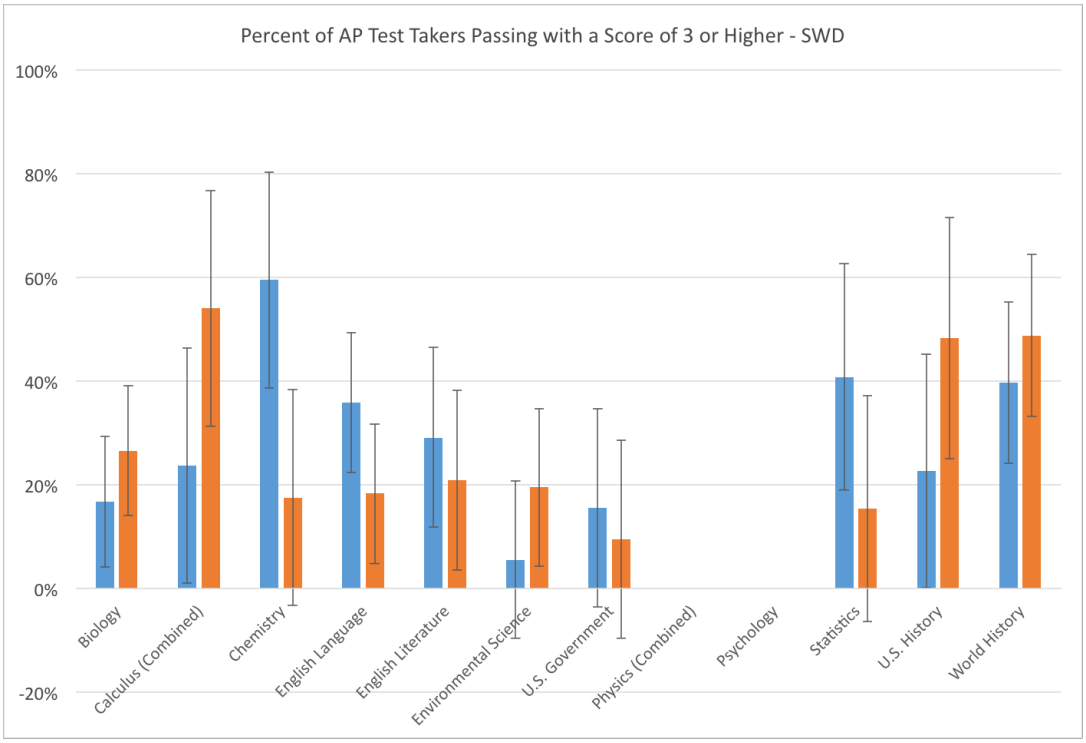
Chart 15 below illustrates the difference in AP Score means between students with disabilities (SWD) in the comparison and treatment groups.

Chart 15.



In addition to an increase in AP score means, students receiving special education (SWD) services also passed AP tests at a higher rate across courses. Chart 16 illustrates the difference in AP test pass rates by course by students in the comparison and treatment groups. The data in this chart represents an anomaly in the AP pass rate data overall. Not only do the error bars suggest significant variability within the data but in many cases the data suggest the percentage of students with disabilities that passed AP tests has decreased when compared to their comparison group peers. While several courses such as AP Chemistry, AP Calculus (combined), and AP United States History seem to show significant differences between groups, the wide range of variability suggest that those differences may not be statistically significant.

Chart 16.



AP Mean Score and Pass Rate by Intensity of PBL Dosage

Within the data that show gains by students in the treatment (PBL) group, we found that the amount of PBL students were exposed to correlates with an increase in AP score means and an increase in the number of AP tests students pass.

Chart 17 illustrates the positive correlation between the amount of PBL students in the treatment group experienced and an increase in their mean AP scores. This positive correlation is especially striking as it suggests the difference between not passing (overall mean AP score of 2.22) and passing (overall mean AP score of 3.02) associated with more intense exposure to PBL coursework.

Chart 17.

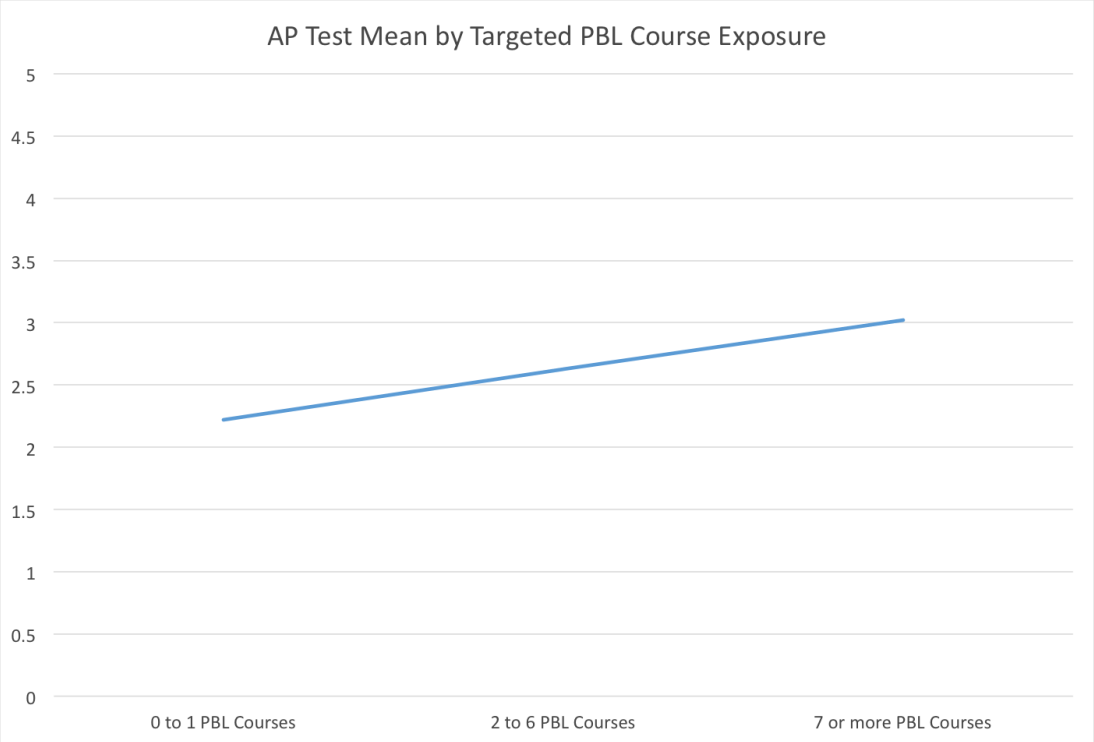
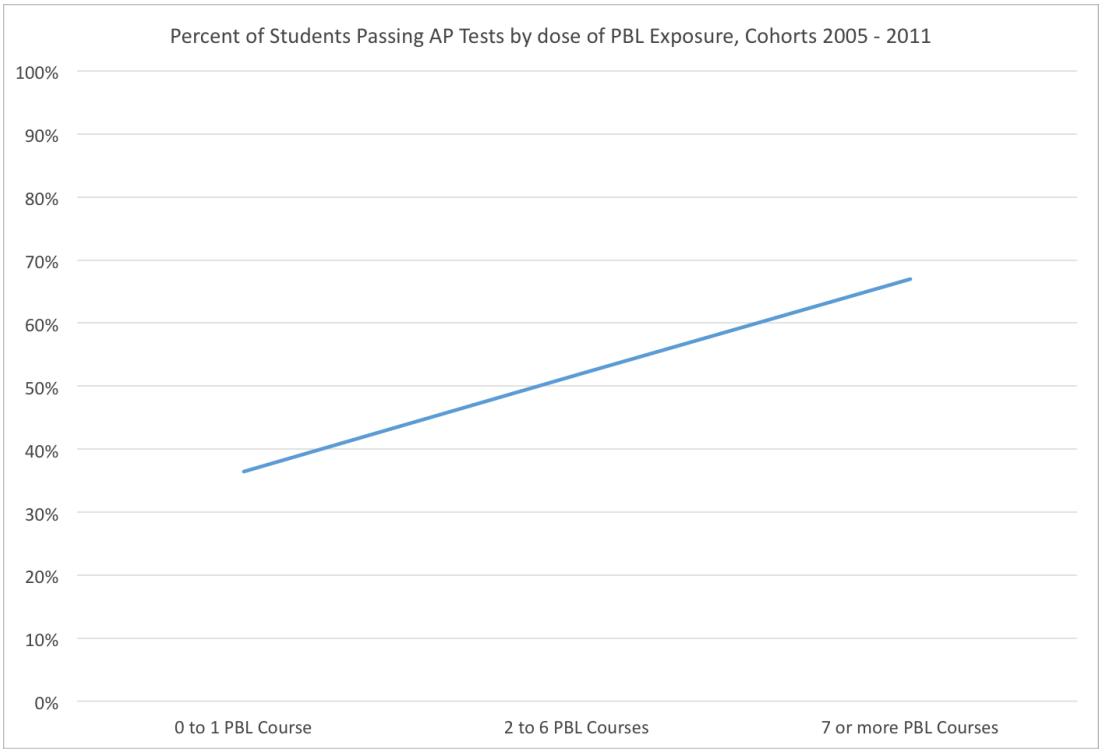


Chart 18 illustrates the positive correlation between the amount of PBL students in the treatment group experienced and an increase in the percentage of AP tests they pass. This trend shows an increase from 36% of tests passed by students receiving a dosage of 0-1 PBL courses to 67% of tests passed by students receiving a high dosage of 7 or more PBL courses.

Chart 18.



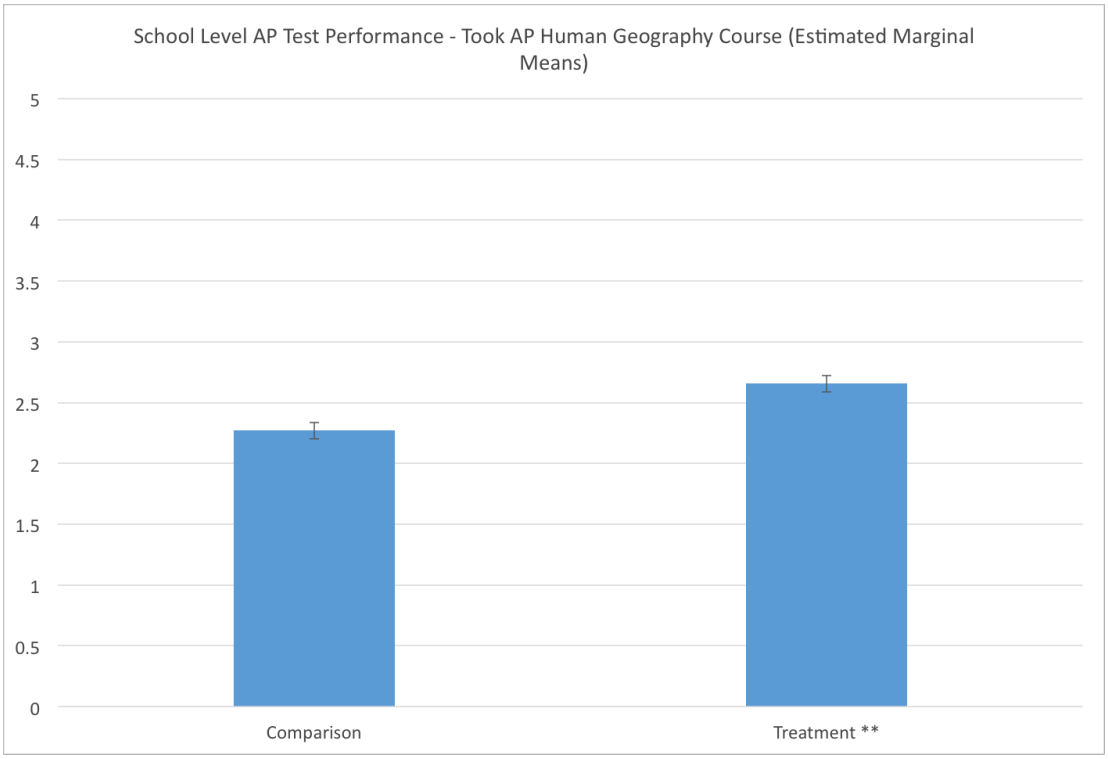
Taken together, these data suggest a positive correlation with PBL and increased student success on AP tests regardless of content-area and regardless of student sub-group. Although not universal, student gains in AP scores are wide spread and on the upward trajectory across courses within content areas.

Assessing the Impacts of AP Human Geography as a Common AP Experience for Incoming Freshmen

Designed and implemented as a PBL course in 2011, AP Human Geography was one of the first courses to be implemented and was required for all freshmen attending Sammamish High School. Research suggests that students benefit from the experience of taking AP coursework early in their high school careers and that such an experience can have positive impacts on their performance in future coursework (Rodriguez, McKilip, Niu, 2013). School leaders wagered that requiring AP Human Geography for all incoming freshmen would provide them with a strong foundation in the skills necessary to be successful in future PBL and AP coursework. Because students may have taken AP Human Geography but not the test, we examined how both groups (course takers only and course takers and test takers) of students fared in future AP coursework. It is important to note that these data reflect teachers' first effort to implement this course. AP Human Geography teachers have told us in interviews that the course has been greatly improved since 2011.

Chart 19 illustrates the difference in mean AP scores by AP Human Geography course takers who did not take the test in the treatment group and students in the comparison group. AP Human Geography course takers who did not take the test (2.655 mean score) outperformed students in the comparison group (2.26 mean score). These differences were statistically significant.

Chart 19.



For students who took AP Human Geography and who took the test, the differences were more pronounced, resulting in a difference of 2.29 mean score (comparison group) and 2.74 mean score (AP Human Geography test takers). Chart 20 illustrates those differences.

Chart 20.

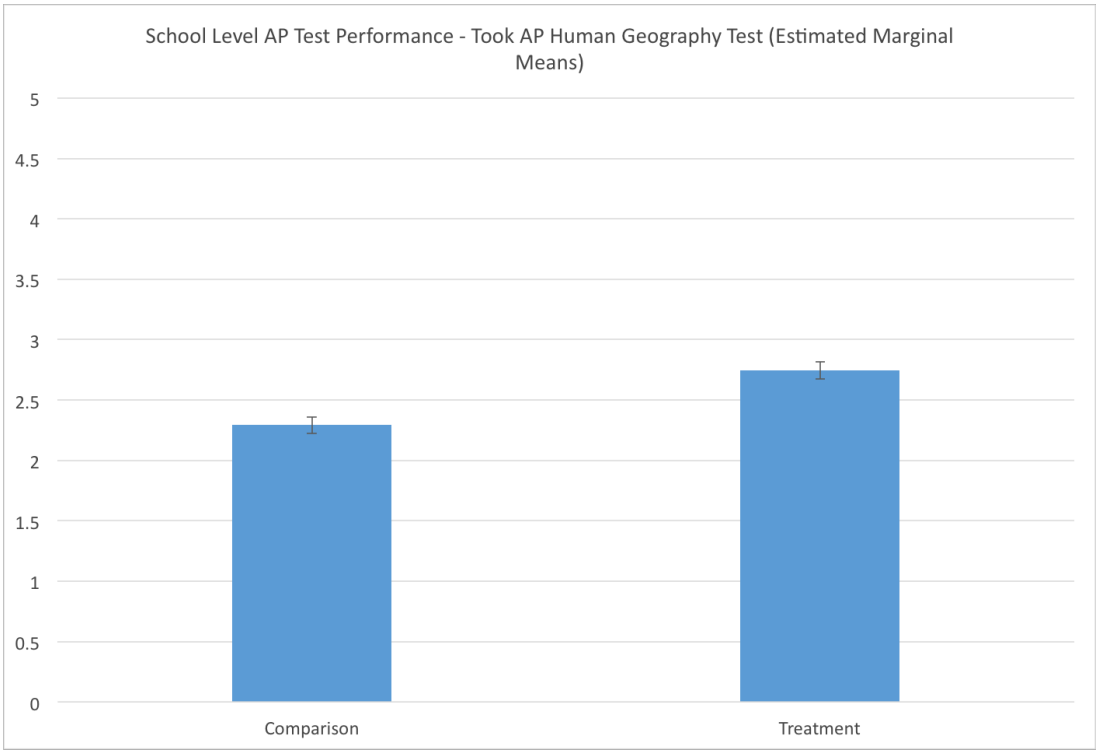
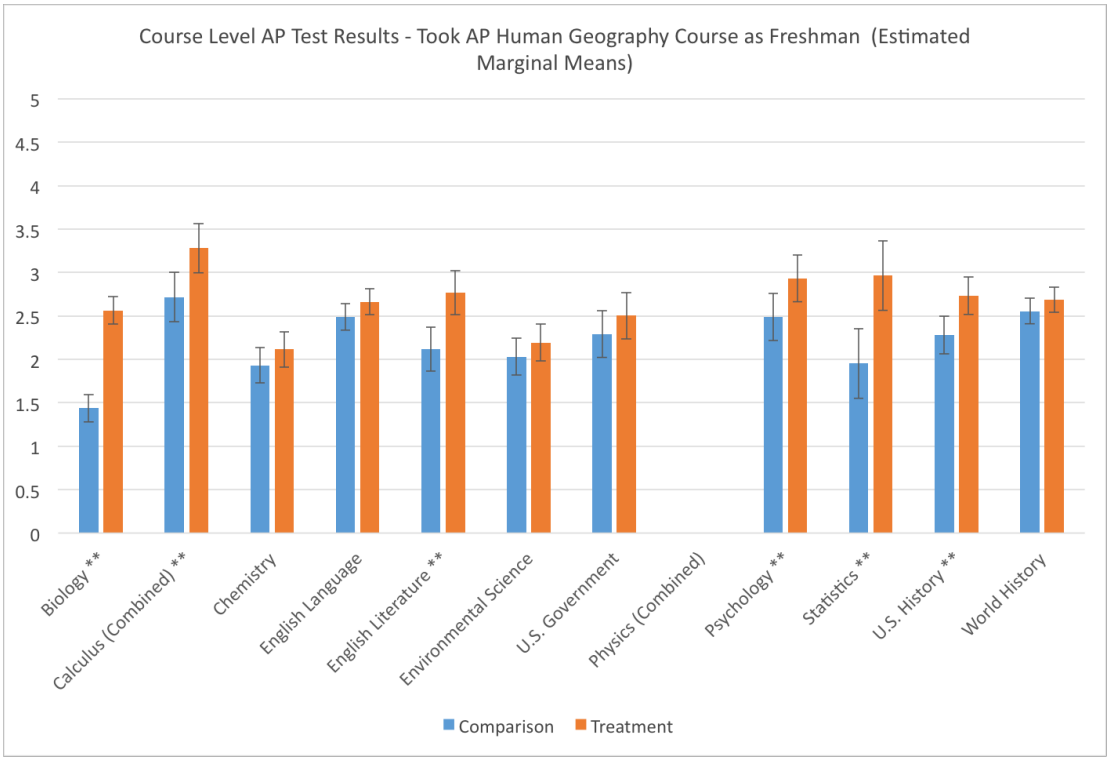


Chart 21 illustrates the differences in mean AP scores between students in the treatment group who took AP Human Geography, but did not take the test, and students in the comparison group. Students in the treatment group, who took AP Human Geography but not the test, outperformed students in the comparison group across the board. In AP Biology, AP Calculus (combined), AP English Literature, AP Psychology, AP Statistics, and AP United States History, student gains were statistically significant.

Chart 21.



Again, for students who took AP Human Geography test, the differences were more pronounced across courses. In AP Biology, AP Calculus (combined), AP English Language, AP English Literature, AP Psychology, AP Statistics, AP United States History the differences in AP score means were statistically significant. Chart 22 illustrates differences in mean AP scores between the comparison group and the treatment groups of students who took the AP Human Geography test.

Chart 22.

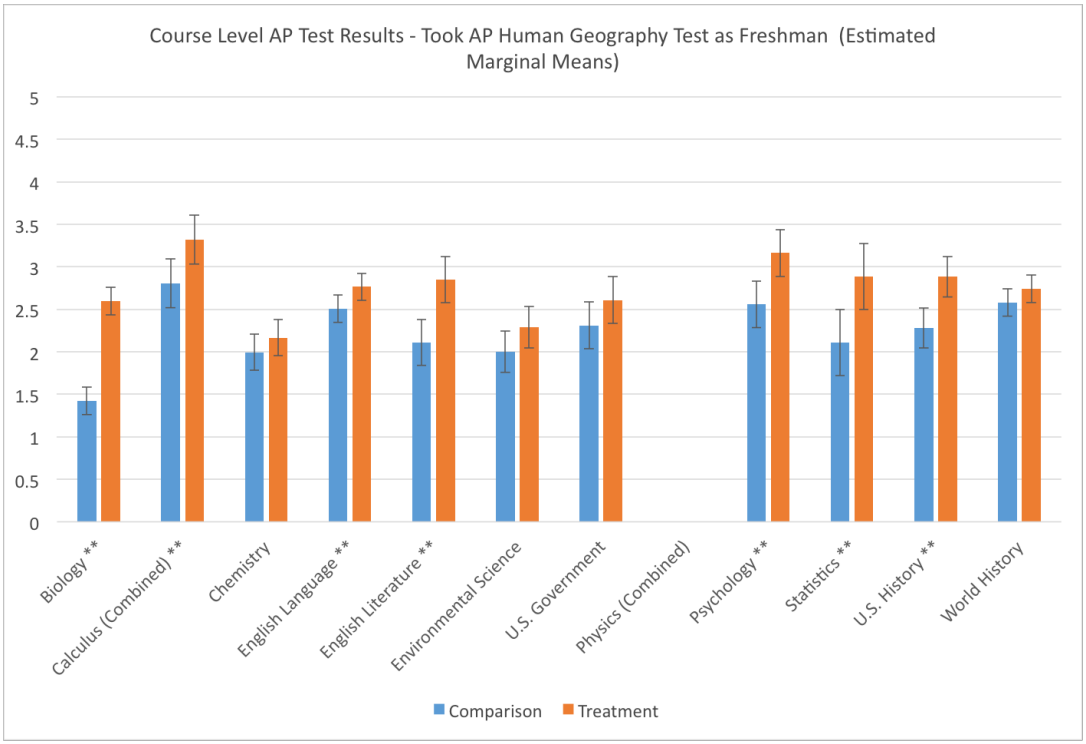


Table 28 below compares the mean AP scores of all students included in Exploratory Study #1 (mean AP scores). This includes mean AP scores from students in the comparison group, all students in the treatment group, students within the treatment group who took AP Human Geography but did not take the test, and students who took the AP Human Geography course and the associated test.

Table 28.

Comparison of Mean AP Scores Between All Students in Exploratory Study #1: Mean AP Scores				
AP Course	**Comparison Group Students**	**All Students in the Treatment Group**	**AP Human Geography course takers, not test takers**	**AP Human Geography test takers**
AP Biology	1.624	1.973	2.562	2.597
*AP Calculus (combined)	2.643	2.955	**3.283**	**3.321**
AP Chemistry	1.809	2.029	2.114	2.165
*AP English Language	2.515	2.545	2.663	2.765
*AP English Literature	2.44	2.523	2.766	2.848

**AP Environmental Science	2.07	2.155	2.194	2.288
**AP United States Government	2.387	2.666	2.505	2.607
*AP Physics (combined)	**3.297**	**3.466**	NA	NA
*AP Psychology	2.531	2.902	2.935	**3.163**
*AP Statistics	2.079	2.224	2.966	2.889
AP United States History	2.102	2.615	2.734	2.882
AP World History	2.497	2.632	2.687	2.74

(*) Designates courses not redesigned as part of the i3 grant.
(**) Designates courses redesigned into project based learning previous to the i3 grant. [Insert footnote here]
Bold numbers signify mean passing AP score

Two things are noteworthy in Table 28. First, treatment group students' mean AP scores improve as they take AP Human Geography and the associated test. Second, the increases in mean AP scores are not limited to only the courses that were redesigned into PBL courses. Students also experienced increases in their mean AP scores in the courses not redesigned according to PBL pedagogy as part of the i3 grant.

Exploratory Study #1a

The motivation to explore AP Test performance and pass rates stemmed from the completion of an exploratory Interrupted Time Series study. This study compared pass rates, as defined by the number of AP Test passers in each department by the number of students they served in a given year. The pre-data points were the number of passers in courses not yet redesigned while the post data were from the number of passers who had taken redesigned PBL courses. Because courses came online in a staggered fashion it was necessary to code the data in such a way to account for varying implementation times. A regression analysis was conducted using the following model:

$$\text{Passers per Dept.}_{st} = \beta_0 + \sum_{s=1}^{N_s-1} \gamma_s(\text{Indicator for Subject s}) + \beta_1(\text{Indicator that Course is using PBL in year t}) + \epsilon_{st}$$

Table 28a below provides an overview of which courses were analyzed and the pre or post designation for each. By analyzing the data at the department and whole school level we found that taking PBL redesigned courses was associated with increased pass rates for Social Studies and Science. These findings were confirmed in the follow-up exploratory study #1 described above.

(For more information about this preliminary exploratory study please contact the authors.)

Table 28a.

Department (E6: All Departments)	School Year / Course	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
E1. Social Studies	US Government	O	O	O	O	O	O	O	O	X	X	X	X	X
	Comparative Government	O	O	O	O	O	O	N	N	N	N	N	N	X
	Human Geography	N	N	N	N	N	N	N	N	N	X	X	X	X
	US History	O	O	O	O	O	O	O	O	O	O	O	X	X
	World History	O	O	O	O	O	O	O	O	O	O	X	X	X
E2. Science	Biology	O	O	O	O	O	O	O	O	O	O	X	X	X
	Chemistry	O	O	O	O	O	O	O	N	O	O	X	X	X
	Environmental Science	N	O	O	O	O	O	O	O	X	X	X	X	X
	Physics	O	O	O	O	O	O	O	O	O	O	X	X	X
E3. English	English Language	O	O	O	O	O	O	O	O	O	O	X	X	X
	English Literature	O	O	O	O	O	O	O	O	O	O	X	X	X
E4. Math	Calculus	O	O	O	O	O	O	O	O	O	O	O	X	X
E5. World Language	Spanish Language	O	O	O	O	O	O	O	O	O	O	O	X	X
	Chinese Language	N	N	N	N	O	O	O	O	O	O	X	X	X

Impact on Special Populations: English Language Learners

English learners (ELs), students whose first language is not English, are not only the fastest growing school-age population but also a tremendously diverse group representing an abundance of cultures, languages, nationalities, and socioeconomic backgrounds. The majority of students who comprise the EL population are US citizens. Nationally, more than 75% of ELs in grades K-5 are second- or third-generation Americans, and 57% of middle and high school ELs were born in the United States (Grantmakers for Education 2013). The belief that English learners are students who have recently moved to the US is inaccurate. More and more students with parents from diverse backgrounds are growing up in the US who need ELL accommodations.

Washington State Legislature defines English learner (Chapter 28A.180 RCW) as "any enrollee of the school district whose primary language is (one) other than English and whose English language skills are sufficiently deficient or absent to impair learning." The definition indicates a lack of English proficiency and that English is not the first or primary language of the student. What the definitions fail to indicate is the range of academic experiences these students bring into the classroom. Some ELs at Sammamish High School are coming in with having successfully completed rigorous academic courses in their native countries, while others, because of their journeys, have had interrupted educational experiences.

The absence of this information creates a limited view of the students.

At SHS, ELs make up 15% of the student population. 38% of SHS students speak one of the 45 different reported languages other than English at home. While the most common language is Spanish in the district, the others include Chinese, Korean, Russian, Japanese, Vietnamese, and Telugu to name a few. And within these language groups are varied academic, linguistic, and life experiences. The term English learner does not display the multitude of layers within the label.

Focus Group Demographics

Fifty students made up the 13 focus groups, which were conducted during the English Language Development (ELD) classes at the end of the 2014-2014 school year. The group's configurations were based on advice from the ELD instructors with regards to peer dynamics since the focus groups conversations took place during their class. Each group's demographics are detailed in Table 29 below.

The aggregate demographics were:

- 23 female and 27 male students;
- 8 ninth-grade students, 9 tenth-grade students, and 33 eleventh- and twelfth-grade students;
- 13 beginning level students, 17 intermediate level students, 20 advanced level students; and
- 18 Spanish, 10 Mandarin, 9 Vietnamese, 4 Korean, 2 Hindi, 2 Cantonese, 1 Persian, 1 Russian, 1 Punjabi, 1 Japanese, 1 Tagalog, and 1 Taiwanese speakers.
- The range of stay in the US was from 2 to 60 months.

Table 29.

Focus Group	Number of ELs (n)	First Languages (n, language)	Grade Level	Gender? (n, female / male)	WELPA Language Level (Beginning – Advanced)	Length of time in the U.S.
A	4	1 – Russian 1 – Spanish 2 – Vietnamese	9th	4 - Female	2 – Beginning 1 – Intermediate 1 – Advanced	7-30 months
B	3	1 – Korean 2 – Spanish	9th	3 – Male	2 – Beginning 1 – Intermediate	2-48 months
C	5	2 – Korean 1 – Mandarin and Cantonese 2 – Vietnamese	11th 12th	3 – Female 2 – Male	3 – Intermediate 2 – Advanced	24-48 months
D	5	2 – Spanish 3 – Vietnamese	11th 12th	5 – Male	2 – Beginning 1 – Intermediate 2 – Advanced	12-24 months
E	2	2 – Vietnamese	11th 12th	2 – Male	2 – Advanced	24 months
F	4	1 – Cantonese 3 – Mandarin	10th	3 – Female 1 – Male	2 – Intermediate 2 – Advanced	5-24 months
G	4	3 – Spanish 1 – Tagalog	10th	2 – Female 2 – Male	2 – Beginning 1 – Intermediate 1 – Advanced	6-24 months
H	5	1 – Japanese 1 – Korean 1 – Mandarin 1 – Mandarin and Taiwanese 1 – Punjabi	11th 12th	5 – Female	1 – Intermediate 4 – Advanced	18-36 months
I	3	1 – Cantonese 1 – Mandarin 1 – Punjabi and Hindi	11th 12th	3 – Male	2 – Intermediate 1 – Advanced	18-36 months
J	2	1 – Persian 1 – Spanish	9th 10th	2 – Female	1 – Beginning 1 – Intermediate	5 to 9 months
K	2	2 – Mandarin	11th	2 – Male	2 – Advanced	42 months
L	5	1 – Mandarin 4 – Spanish	11th 12th	2 – Female 3 – Male	2 – Beginning 3 – Intermediate	5 to 36 month
M	6	6 – Spanish	11th 12th	1 – Female 5 – Male	2 – Beginning 1 – Intermediate 3 – Advanced	3 to 24 months

How do ELs Describe Their Experience with PBL in Mainstream Math, Science, and Social Studies Classroom?

Twenty-eight of 50, 56% of ELs said they did not connect with PBL as a pedagogical model. Reasons cited included the dislike of group work associated with PBL and that PBL isn't connected to the real world. Another explanation is the difference in learning styles to the ELs' prior academic experiences. FGB4, a student from Korea who had been at SHS for two months at the time of data collection explained, "(I) do not feel connected to the projects. (It's a) waste of time. All subjects in home school were text books and tests. Trying to learn on your own is better." For some ELs, PBL is drastically dissimilar to the classrooms they are familiar with. Even for ELs who have had experience with projects, PBL can be challenging because of the complex and massive language demands in some content areas. FGB4, a student from Mexico who had been in the US for three months at the time of data collection said, "I worked on a lot of projects in home country, but I no understand here." Not having the appropriate language scaffolds prevents ELs from understanding the content presented. And without connections to prior knowledge, the potential resources ELs could implement may go untapped.

Of the three content areas, ELs connected the most to science and when there was choice in the PBL topic. FGG4 explained, "(I like) project where you can pick any topic you want." Several students brought up student choice projects such as the Independent Project in science and the History Day project in social studies. The following sections discuss each specific content area.

Math. ELs expressed that there was limited PBL in math with 15 of 50 (30%) saying that there was no PBL in math. The students who talked about PBL in math expressed a dislike for the projects because they did not see the connection between the project and the content. One student explained FGF3, "I don't understand why we did the robot project in (pre-calculus) class." The robots were used as part of the PBL unit the pre-calculus classes were utilizing. Students were given a choice of any topic in the textbook they were interested in building a unit around with lesson plans, assessments, and the use of a robot to teach the concept. Without contextualizing the PBL, students will miss important connections and relevance between content and PBL.

Science. Comparing the number of ELs who said they liked PBL in content areas, science came out on top with 18 of 50 (36%) ELs expressing their enjoyment of PBL in science. FGA4 exclaimed, "Science has the best project because of experiments." Seven of the 18 said it was because they were able to choose their topic. 6 of 50 communicated concern with science PBL because of the difficulty and layers involved in completing the culminating project/aspect of the unit. FGD3.2 explained, "Science is the most difficult class. I never saw (the content) before, so the teacher said you need to talk about it with your partner, but I don't even know what to talk about." Understanding the content is a prerequisite for participating in collaborative and PBL activities. And because instruction and materials are given in a language ELs are still acquiring, additional resources such as summaries of research and scientific articles and native language tools would be useful in equipping ELs with content knowledge. Even though science involves dense academic vocabulary and concept, 14 ELs described a favorite project/unit in science. FGK3.2 explained, "My fav project was the GMO project because I just watched news from China about the topic and my relatives and I were so exciting to discussing it over the phone." PBL that has authentic connections to the ELs' lives are engaging and motivate students to become more involved.

Social Studies. With social studies, 11 of 50 (22%) expressed liking PBL with the same number expressed not liking PBL in social studies. Sixteen ELs (32%) said social studies had the most PBL activities. The PBL in social studies was consistent with each unit culminating in a product and presentation of some form. FGH3.3 explained, "After we finish a project, we start another project." And FGG3.3 explained, "We have to do so many projects in history!" The mixed reactions to PBL in social studies stemmed from interest in the topic, relevance, and the projects. FGF3.3 explained, "Yes, there are a lot of projects. My favorite is to make the film where we picked a topic and make a video about it. Mine was about Queen Victoria." Having choice in PBL was a motivating factor for many ELs. FGH3.3 explained, "I don't like government project. It's all about political things. I don't connect with the content. They are really hard topics that you don't even know about." Many ELs described favorite projects in social studies including the children's book and history day projects in World History. FGJ3.3, "Favorite project was the children's book because this is very good. It's for helping kids." The ELs that revealed challenges with social studies PBL described difficulty with the understanding and connecting to content, presentation, and group work. FGI3.3 explained, "There are a lot of projects in history. Projects are too hard. I don't know what to research about." And FGL3.3 explained, "I like the class (social studies). But I don't like when we do projects because when we work in groups sometimes it is only one or two people doing the work." Similar to reactions with science, ELs are also frustrated with group work in social studies.

What Specific Expectations Do They Find Challenging Within the Environment?

Issues brought up can be grouped into two areas: language and PBL. Language expectations refer to the plethora of language demands in the mainstream classrooms, and the PBL expectations pertain to the activities and curriculum related to problem-based learning utilized in the classroom.

Language Expectations. Because instruction, interactions, and assignments are all conducted in a language ELs are still mastering, productive engagement with content and activities is difficult and require extra time and resources for ELs. FGJ2 and FGL2 both expressed engaging with content "when (they) understand what is going on in class." Comprehension of what is happening in the classroom is foundational to engagement with the material and activities in the classroom. For some, understanding the instructor is a challenge. FGB3.3 explained, "It's hard to understand the teacher and the material, I prefer to read textbook and taking a test." Other ELs who enjoy learning in a particular content area find school challenging because of the language barrier. FGJ3 explained that "I don't like projects in there, the words are really hard and I can't understand the words, I love(d) geography in my country." In this case, the student enjoyed social studies in her home country but is unable to feel the same way here because of language.

Many students expressed anxiety with presentations in both social studies and science classrooms. FGI4 explained, "I learned a lot from every project, but it's hard to do the presentation part." Speaking in front of an audience of peers can be a nerve-wracking experience for many. For students who are still learning English, the experience can be paralyzing. However, there are moments of relief as FGH3 conveyed, "I liked the broadcast project because when we presented, we could hide behind a poster board because it was a radio broadcast." Because language is the key to comprehension and participation in the classroom, equipping ELs with academic language and providing opportunities for comprehensible input

and output will increase their engagement and progress.

PBL Expectations. PBL at SHS consists of units in each course that are designed and implemented by teachers in the content area's department. Each of the content areas, math, science, and social studies, have several design teams that create PBL units aligned to state standards and district content requirements. Units are designed with the seven key elements (listed in the Methods section) in mind to provide an authentic and relevant real world problem for students to tackle. Many of the units require group work to create a product and/or culminating solution to be presented to various audiences. For many ELs, problem-based learning is a new type of learning environment with activities, content and academic skills which are unfamiliar.

Many ELs did not see the value of projects because they are used to the banking model of education where teachers are positioned as knowledgeable and where teachers present the knowledge to the students and then assess the students on the understanding of the materials. FGA3.3 explained, "I don't like working on PBL because I prefer to be writing things, and the teacher to be explaining." Providing an explanation of PBL and its benefits would provide ELs with a better understanding of the structure and potential rewards of engaging with a more complex type of instruction and learning environment.

One major component of PBL is collaborative activities where students are asked to work together to complete a project or to provide a solution to a problem. ELs feel a lot of pressure because of grades and anxiety towards bringing the group's grade down because they feel overwhelmed by the project. FGK5 explained, "Some students they help you. They want you to understand. Some other type of students, they don't want you to waste their time and their grade, so in that time, they are just so hard." Fostering effective collaborative techniques and behavior are pivotal in ensuring students are working efficiently and productively and feeling supported by the team for ELs and non-ELs.

Group member selection was also an issue of concern for the ELs. FGF5 explained, "Teachers should set up groups because it is hard to find other team members." FGI5 provided an example; "More teammates. Like everyone chose their group first. Nobody knows me there, so I'm the only person left and the other two students in my group never shows up to class."

Teacher Support

When asked about the types of supports the ELs wanted in the classroom, 39 of 50 (78%) students talked about the need for more assistance from teachers. The teacher support ELs asked for ranged from explanations of content to participation in collaborative activities. Seven ELs asked for teachers to provide slower and clearer explanations. FG5F explained, "Slow down a bit when explaining important concepts." Before engaging with PBL, an understanding of the foundational content is pivotal. Another aspect of support relates to participation. FG5A explained, "Teacher provide more support. She should go around and say you have to participate." For students who are unfamiliar with the norms and rules of PBL activities, clear instructions for and encouragement of participation from the instructor would ease ELs anxiety with unfamiliarity.

ELs found a number of teachers to be accommodating and extra helpful to them. FG5C explained, "Teachers are nice and they help me a lot this year, especially Duke Slater (pseudonym for ELD teacher). We need to have a lot of writing, and I always bother him to help me, and he always so patient and explain to me a lot and give me so many helps." Many of the ELs turned to their ELD instructor because they felt comfortable asking them for help, as the instructor fully understood the challenges they faced in the

classroom and believed in their potential. Another FGL5 explained, "Teachers can be nice to everyone, not all the time, sometimes you need do the job for students to understand, need to make sure the students understand what is going on, check homework all the time." Unfortunately, the ELs did not find all teachers to be friendly and helpful. FG5D explained, "Some teachers are not helpful. They know about you (EL status), but if you ask them questions, they don't care." Another student in the same group expanded, "Teachers, some are so mean. They don't want to help you. You ask them questions and they don't answer." FG5E saw promise in teachers with the positive core belief, "It's the most important that they WANT to change to help ELs." The ELs were able to sense that some of their teachers did not want to support their learning if it meant having to provide additional supports beyond their required teaching load.

Other requests by ELs included the use of their native languages in the classroom to understand the material and connect with the content. Another one relates to group work. A majority of PBL activities is completed in groups and because ELs are new and often the minority in the classroom, it can be challenging to find group mates. FGH5 explained, "Grouping us with friends makes us want to do the project more." Being able to work with peers that they already have a relationship with may ease tensions around group dynamics. Teachers could also implement activities to build a classroom community, in which collaborative peer relationships could grow. Teacher support and the implementation of purposeful scaffolds and explicit connections are desperately needed for ELs to productive engage with PBL in mainstream content area classrooms.

Summary of Findings

The data show that the language demands associated with PBL represent a significant obstacle to English Learners. English Learners are forced to learn two languages in a PBL classroom: the discourse associated with the content and the social language needed to negotiate and navigate roles and expectations with peers. We recommend teachers provide English Learners with support materials and linguistic tools in order to comprehend foundational content before engaging with PBL tasks. Teachers should allow students to use their native language in the classroom to connect to prior knowledge and access resources. Both findings support a more robust approach to helping English Learners become more linguistically proficient, both academically and socially, in the classroom.

In addition, teachers should take explicit steps to help English Learners socialize into a PBL classroom. PBL components need to be explicitly explained for ELs who may not be familiar with the type of learning environment. Teachers need to build cultural sensitivity activities into students' day-to-day learning. Teachers need to build community within the classroom to create a safe environment to take risks. Many students expressed sadness and frustration that their native English-speaking peers treated them negatively in small group settings when they would struggle to understand social cues or to keep up with the fast-paced used of social English in those groups. Teachers should take explicit steps to position ELs as knowledgeable and powerful contributors to the problem-solving task. Lastly, teachers should group students intentionally and purposefully depending on the goals of the task. At times this may mean grouping ELs together. At other times this may mean placing students in heterogeneous groups. Either way, teachers should implement norms to group work to ensure more egalitarian participation patterns and a more egalitarian division of labor in big projects.

Like many other students, ELs told us they are more motivated to learn and more engaged in learning activities when they feel that learning is both relevant to them personally and authentic to work

performed by professionals and industry experts in a given field. When appropriate, teachers should provide more explanation to make connections between the work they do in school and the work professionals do in the work place clear. Teachers should also keep in mind that relevance extends beyond what students are interested in and encompasses the skills students have that can transfer to any specific task. For example, students who have experience building computers with peers or adult mentors have knowledge of design principles and processes teachers can leverage when considering the tasks they ask students to complete. Teachers should design lessons and units with flexibility in mind, designing multiple ways students can succeed on tasks, assignments, and assessments. Lastly, student choice is critical. Whether students are designing a new drug to fight cancer, or negotiating a treaty to govern resource exploration in the Arctic, or writing an essay, teachers should design various ways students can participate in those tasks to evidence their mastery of the focal skills and content.

PBL Adoption and Comparative AP Scores by Department

Although core content area design teams and departments received generally the same amount of resources and support from school leaders, departments experienced policies associated with the PBL curriculum project differently.

Social Studies. The Social Studies department approached the school's PBL initiative with enthusiasm. A member of the department was hired as a teacher leader tasked with developing the professional learning experiences that supported teachers' PBL design and implementation process. Along with another teacher in the department, this teacher was also part of the Knowledge in Action (KIA) research study, led by researchers at the University of Washington and funded by the George Lucas Educational Foundation (GLEF). This study provided teachers with support to redesign the AP United States Government course according to project-based learning pedagogy. These teachers' success with the AP Us Government course gradually influenced the work other Social Studies teachers were doing in their courses. In part because of the work these teachers experienced, initially there was enthusiasm and excitement for PBL amongst Social Studies teachers and emerging project based learning expertise within the department when the SHS PBL curriculum work started.

Since the beginning of the grant, the Social Studies department lost only one teacher. From time to time other teachers went on maternity leave, but the core of the department has remained stable throughout the life of the PBL project. Since the beginning of the project, a vast majority of the required courses offered within the department have been redesigned into PBL courses, this includes AP Human Geography (9th grade course), World History and AP World History (10th grade course), AP United States History and AP American Studies (11th grade course), AP United States Government and AP Comparative Government (12th grade course). Teachers of those courses continue to refine, revise, and improve the PBL pedagogical model they use to teach in those courses.

English. The English department approached the school's PBL initiative with a mix of suspicion and enthusiasm. In the 2011-2012 school year, two design teams worked to redesign the Freshman English and Sophomore English courses. The Freshman English team successfully redesigned most of the existing units in the Freshmen English curriculum. The Sophomore English team designed two units for the new Sophomore English course. In the 2012-2013 school year, another team successfully redesigned much of the existing Junior English course into PBL curriculum. In the 2013-2014 school year a Senior English course worked to redesign the non-AP Senior level course and another team worked with two teachers from the Social Studies department to create a new, inter-disciplinary AP American Studies course.

At the time of writing, an English teacher and Social Studies teacher continue to teach the AP American Studies course, but little PBL curriculum designed by previous design teams continues to be taught within the department. The AP Language and AP Literature courses have not been targeted for redesign by the school. From 2010-2015, the English department lost almost half of the teachers within the department who were there when the PBL curriculum project started. Of the teachers that remain from the beginning of the grant, the data demonstrate they have largely become indifferent to PBL pedagogy and have largely abandoned PBL as a guiding pedagogical model in their practice.

Math. The Math department approached the school's PBL initiative with a mix of suspicion and enthusiasm. In 2010, several teachers led sessions at the Sammamish Institute of Learning and Teaching (SILT). The Algebra II, Geometry, and Pre-Calculus courses were redesigned with varied levels of success. The Algebra II team redesigned a majority of the units for the next year's Algebra II curriculum. However, the year after this course was redesigned, the district shifted to a new Math curriculum, leaving the fate of this course in limbo. Today, little of the originally redesigned Algebra II curriculum remains. The Geometry team redesigned half to two-thirds of the curriculum. Both the Algebra II and Geometry teams were caught between the district curriculum and associated assessments, the Key Elements of Problem Based Learning, the Math Common Core State Standards, and state end of course exams that served as requirements for graduation. Theirs was truly the tension between depth and breadth. As a result, both teams worked to design shorter challenge cycles to frame mathematical concepts. Whereas Social Studies courses immersed students in units that spanned several weeks, both Math teams designed challenge cycles that spanned single or several days.

Another tension that emerged within the department was a resistance to disturb a highly defined and articulated vertical alignment between courses to build students' math skills to prepare them to be successful in the AP Calculus AB/BC course many students took their senior year. There was and is a strong belief within the department that this alignment supported students' success in upper level AP coursework. Their progression from Algebra II to AP Calculus AB/BC was the result of myriad hours of thoughtful collaboration within the department to identify specific math skills and content students would need for AP Calculus AB/BC. Instead of abandoning PBL completely, the Math department has worked to strategically integrate the Key Elements into their practice. While there are no "full dose" PBL courses offered in the Math department, much of the teaching and learning students experience in the Math department has been informed and influenced by the Key Elements.

In the first years of the grant, the department also lost 2 veteran teachers to retirement.

Science. The Science department approached the PBL initiative with enthusiasm. One of the Science department teachers was an original member of the teacher leadership team and remains highly involved in components of the ongoing PBL implementation work. Two other Science teachers have also held long-standing positions of leadership within the leadership team. One of those teachers was also heavily involved in the i3 grant writing process.

The Science department recruited 8 teachers to redesign the BioChem course starting in 2010 and continuing through 2011. This course has undergone at least one major revision since it was originally designed and implemented in 2011. In 2012, a design team was assembled to redesign the AP Chemistry course and in 2013 a design team was assembled to redesign the AP Biology course. Both these courses have undergone changes since they were first implemented but they remain focused around PBL pedagogy. A Science department design team also redesigned the core Physics class in 2013. This department's current positive collaborative culture was forged through many tense and candid conversations in the early years of the grant. Since 2011, the department has lost two core members of the department. One of them retired and one transferred to another school in the district. Several Science department teachers have emerged as leaders and experts within the school around the use of technology in the classroom and the integration of external experts into unit design.

World Language. The World Language department approached the PBL curriculum with cautious optimism. However, the department has encountered multiple barriers to designing and implementing PBL coursework throughout the life of the grant. First, it is not uncommon for some world language teachers to teach several (3 or more) language classes at a time, sometimes within the same period. In some cases, teachers within the World Language department are the only teacher at the school who teaches their language. For example, there is and has been only one French teacher at the school for years. It is not uncommon for this teacher to have anywhere from 3 to 5 different classes to prepare for throughout the year, including some AP level courses. Teaching this kind of schedule can be difficult to sustain, especially when teachers are redesigning some but not all courses according to PBL pedagogy. This teaching situation generally holds true for the Chinese teacher and Spanish teachers. Not only do the World Language teachers act as micro departments in and of themselves, but the number of courses offered during any given year can far exceed those offered in some of the other core content area departments. Second, the way courses were redesigned also looked different. For example, the first design team established in the World Language department consisted of the teachers teaching three different languages. While PBL principles can be universal from classroom to classroom, it was nearly impossible for teachers to implement commonly designed curriculum, making the process of professional learning that other design teachers experienced problematic.

For all of these reasons, World Language teachers have found it exceedingly difficult to design and implement PBL coursework with fidelity. However, multiple discussions with teachers within the department suggest that at least some of the World Language teachers use the Key Elements to inform their teaching practice. Given the class, it is not uncommon for students to engage in projects such as simulations using Chinese, French, or Spanish. While World Language teachers use PBL in places, PBL has not yet saturated the way World Languages are taught within the department.

These differences in how specific departments experienced the PBL curriculum design and implementation process may help explain why students experienced different AP score outcomes within each department.

Adoption of PBL Within Departments

To measure the extent to which teachers were adopting PBL, we surveyed teachers using the Concerns-Based Adoption Model (CBAM). We surveyed teachers at the end of the school year, starting in 2011 and continuing until 2015. The CBAM survey was developed in the 1970s at the University of Texas's Research and Development Center for Teacher Education. Organizations and Institutions have repeatedly used the survey to measure the extent to which people adopt an organizational intervention or policy. The survey was developed to "understand what happens to teachers and university faculty when presented with a change" (Hall, Dirksen, and George, 2006, p. 1). The purpose of the survey is to provide a "framework designed to help change facilitators identify the special needs of individuals involved in the change process and address those needs appropriately based on the information gathered through the model's diagnostic dimensions" (Hall, Dirksen, and George, 2006, p. 1).

We used the survey to measure the concerns Sammamish High School teachers and departments felt as they implemented PBL throughout the life of the i3 grant. When paired with modified Levels of Use (LOU) semi-structured interviews with individual teachers directly impacted by PBL course design and implementation, we can understand how teachers were making sense of PBL and the variety of perspectives on PBL that emerged within departments. For this specific evaluation, the CBAM survey

does not provide information on the relative value of PBL or whether or not it was the right intervention for this school at this time. We used it primarily to measure the extent to which departments were adopting and implementing PBL pedagogy in their courses.

Methodology

We administered the survey to teachers during a staff meeting in May or June each year from 2011 to 2015. Before teachers took the survey, we reminded them of the purpose of the survey, what we hoped to learn from their input, and that their responses would be completely anonymous. Table 30 below shows how many teachers took the survey each year.

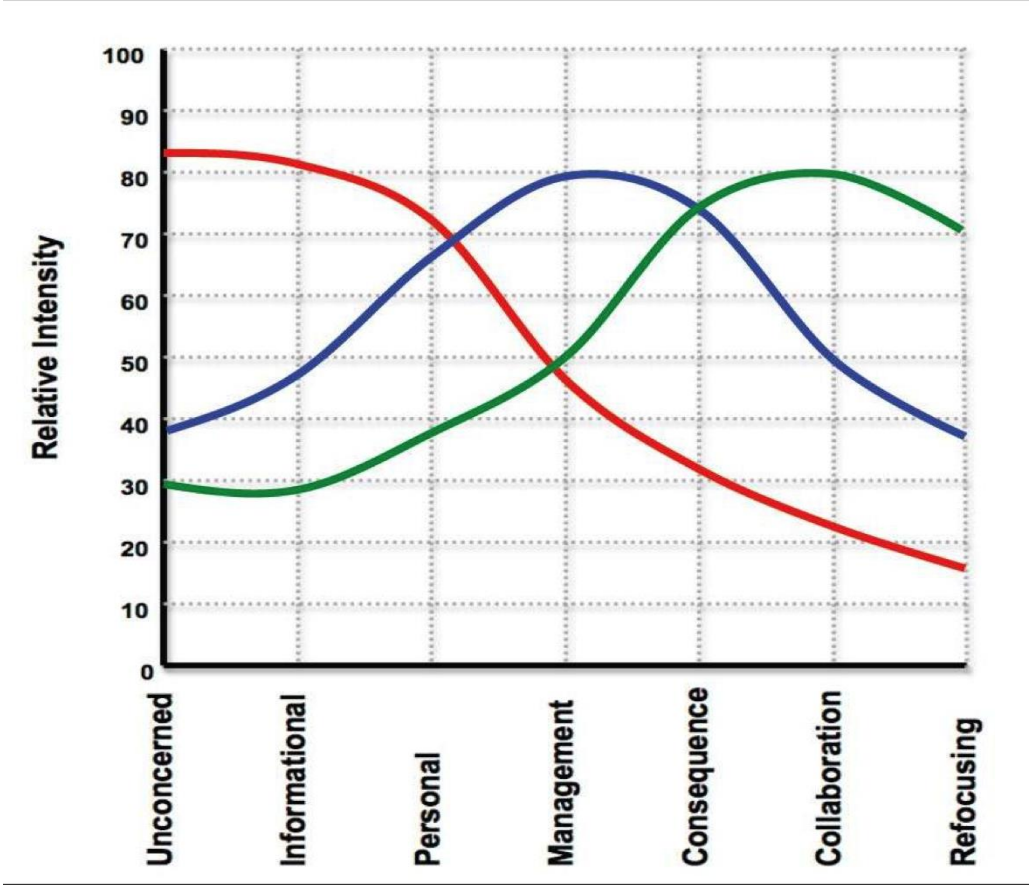
Table 30.

CBAM Survey Respondents by Year			
Year	Survey Responses	Total Number of Staff	Response Rate
2011	51	83	61%
2012	68	70	97%
2013	52	81	64%
2014	55	76	72%
2015	55	75	73%

The numbers of teachers who responded to the survey remained relatively consistent throughout the years of implementation. After teachers took the survey, responses were collected and analyzed by researchers at the Southwest Educational Development Laboratory (SEDL). During the summer we debriefed the results of the survey with the SEDL researchers to identify patterns and trends in the data. Starting in 2014, we facilitated meetings with each department at Sammamish High School to share the findings of their specific survey responses and probe them for insights on the data.

Chart 23 illustrates the kind of long-term adoption trends expected from an organization that is adopting an intervention. The red line, illustrating a high level of concern amongst respondents in the "unconcerned," "information," and "personal" categories is typical for people who are generally concerned about what the intervention is and what it will mean for them. The red line is consistent with responses from people who are experiencing a new intervention or policy. The blue line, illustrating a high level of concern amongst respondents in the "personal," "management," and "consequence" categories is typical for people who are generally concerned about how the intervention is impacting them, how it is being managed on the organizational level, and what consequences will be for people (in this case students) directly impacted by the intervention. The blue line is consistent with responses from people who are in mid adoption and are working to implement the intervention. The green line, illustrating a high level of concern amongst respondents in the "consequence," "collaboration," and "refocusing" categories is typical for people who have adopted the intervention and are most concerned with improving it. The green line is consistent with responses from people who have successfully adopted the intervention.

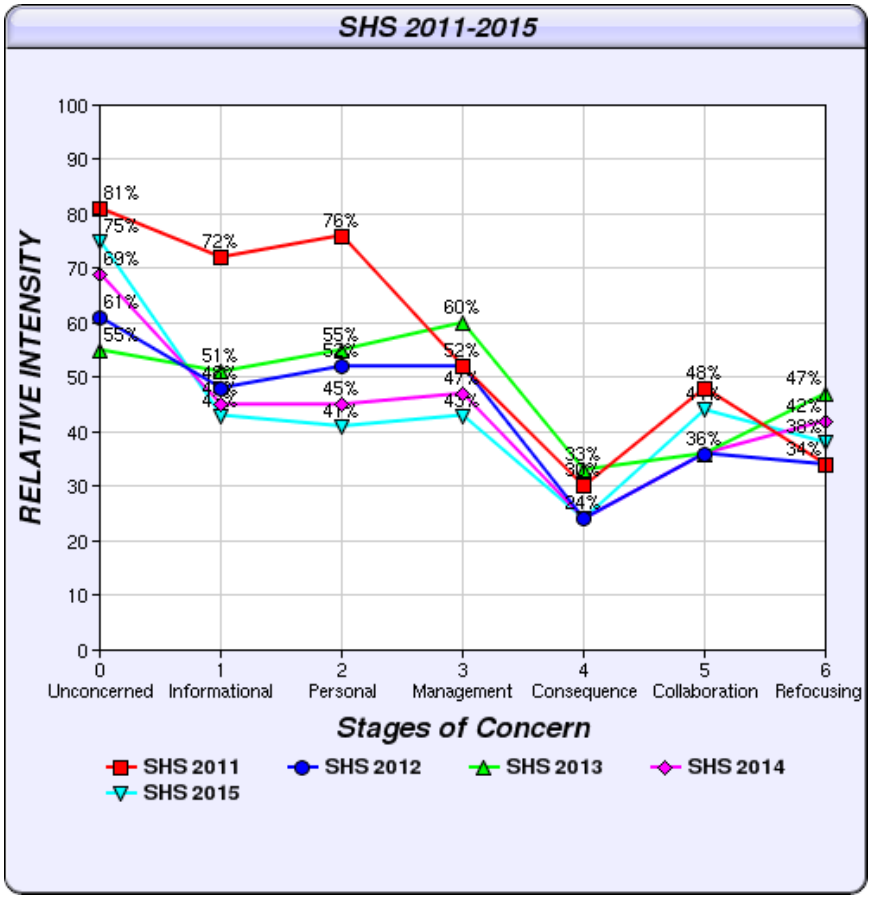
Chart 23.



School-level Findings

School-level survey results show Sammamish High School is trending in a positive direction. Starting in 2011, the data show a school most concerned with PBL and hungry for more information about what it is and how to implement it. In 2012, the school becomes less concerned with knowing what PBL and how to implement it and becomes more concerned with how to manage the implementation (ranging from 43-60%) and time to collaborate with colleagues to improve their implementation of PBL (ranging from 36-48%). These data, illustrated in Chart 24, suggest a majority of teachers at Sammamish High School have adopted PBL, are wondering how they can manage the demands of the PBL instructional model moving forward, and are craving more time to collaborate with colleagues to improve how they enact PBL in their classroom.

Chart 24.

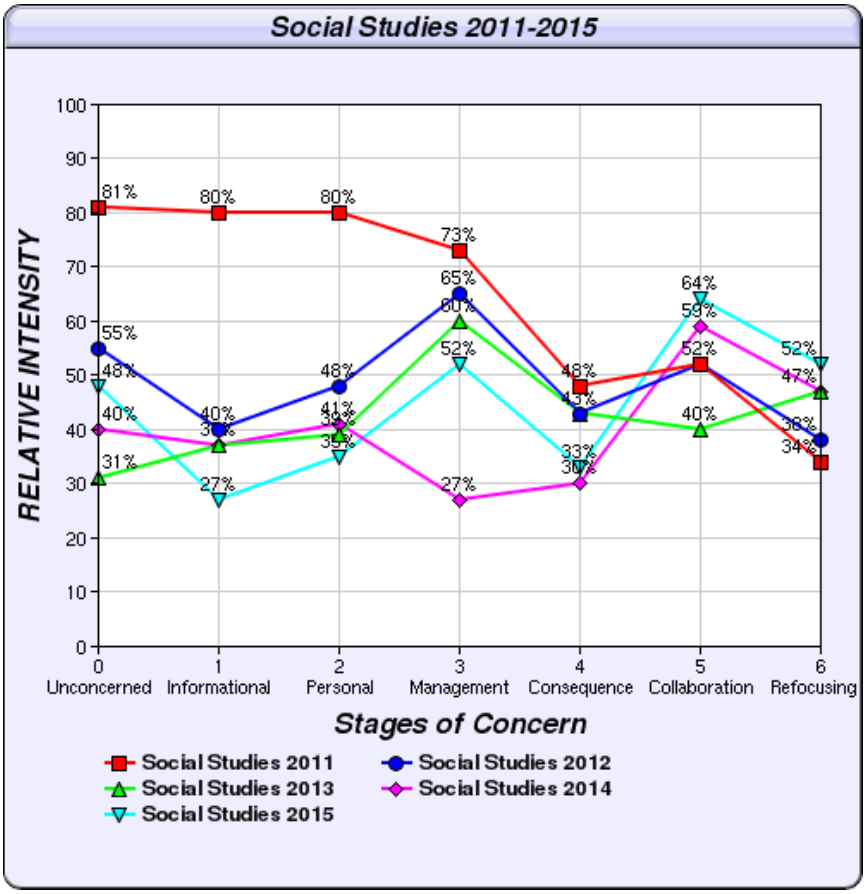


Department-level Findings

Department-level findings portray a more complicated and nuanced picture of adoption trends from 2011 to 2015, indicating 1) the Social Studies and Science departments had fully adopted PBL, 2) the Math department remained hesitant to fully embrace PBL in their teaching, and 3) the English department had abandoned it altogether. Below we share survey response trends from each department from 2011 to 2015 and discuss how their trends demonstrate the extent to which they are adopting PBL pedagogy.

The Social Studies Department. Chart 25 illustrates CBAM response data from the Social Studies department from 2011 to 2015.

Chart 25.



These data suggest teachers in the Social Studies department have successfully adopted PBL. The five year trend suggests they 1) have a good understanding of what PBL is (low in the "unconcerned" and "information" categories), 2) are most concerned with managing how they are implementing PBL moving forward (high in the "management"), and 3) looking for ways to collaborate with each other to improve how they are implementing PBL (high in the "colalboration" category). Qualitative responses from Social Studies teachers support these data. A teacher described working "to implement PBL in ways that are more authentic and more engaging because I see it as critical for student learning." Although there is some variability of perspectives within the department, these data suggest this teacher's perspective is consistent with that of the Social Studies department overall.

These data seem to align with our findings in Exploratory Study #1. Students in the treatment group experienced gains in Social Studies department AP coursework exams. Mean differences are statistically significant when accounting for matched students using GPA, SWD, EngNotFirst, FRL, and Gender as covariates. For this analysis 887 comparison students were matched to 1189 treatment students. Students in the comparison group were allowed to be matched to more than one treatment student making the weighted comparison and unweighted treatment groups to have 1189 students each. AP Test Scores across all Social Studies department tests (U.S. Government, Psychology, U.S. History, and World History) for students in the treatment group (having taken at least one redesigned PBL course in any department) scored higher than the comparison group. As expected, departmental GPA (DepGPA) accounted for the

vast majority of the variance in AP Test scores, but PBL Exposure (BigMatch) accounted for more variance than the SWD, ELL, FRL, or Gender.

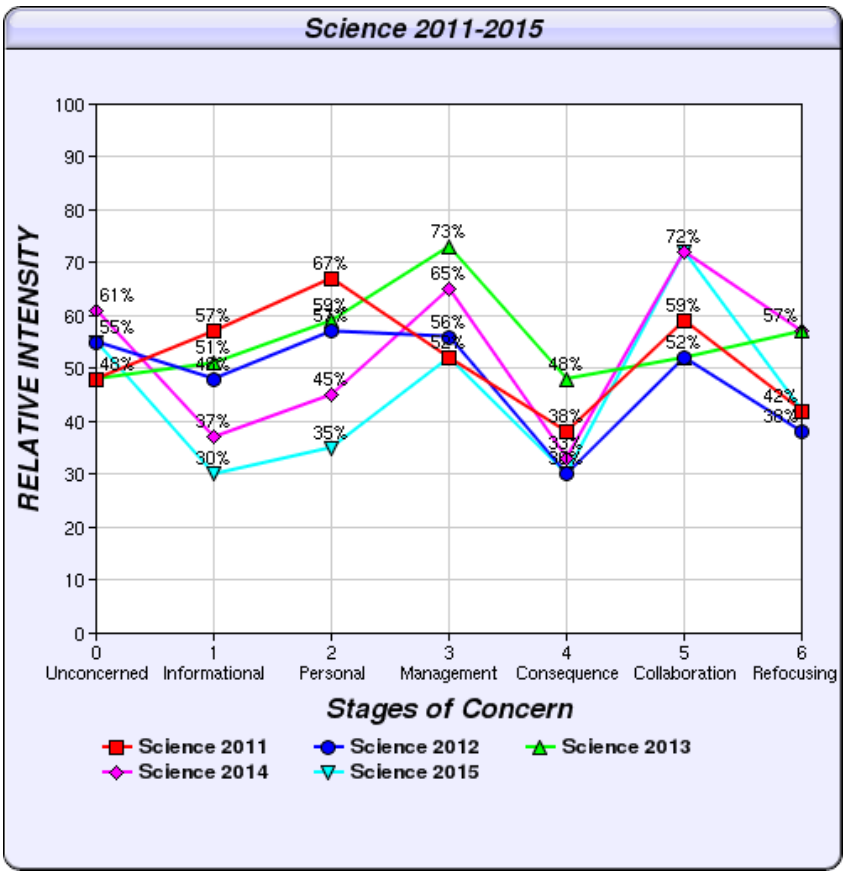
Table 31.

Dependent Variable: Advanced Placement Test Score (Social Studies)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1035.904[b]	6	172.651	157.351	.000
Intercept	1.958	1	1.958	1.784	.182
DepGPA	742.672	1	742.672	676.857	.000
SWD	3.961	1	3.961	3.610	.058
ELL	21.304	1	21.304	19.416	.000
FRL	10.648	1	10.648	9.705	.002
Gender	36.845	1	36.845	33.580	.000
BigMatch	63.668	1	63.668	58.025	.000
Error	2601.545	2371	1.097		
Total	18751.000	2378			
Corrected Total	3637.449	2377			

a. Department = Social Studies
b. R Squared = .285 (Adjusted R Squared = .283)

The Science Department. Chart 26 illustrates CBAM response data from the Science department from 2011 to 2015.



These data suggest teachers in the Science department have successfully adopted PBL. Like data from the Social Studies department, the five year trend in the Science department suggests they 1) have a good understanding of what PBL is (low in the "unconcerned" and "information" categories), 2) are most concerned with managing how they are implementing PBL moving forward (high in the "management"), and 3) looking for ways to collaborate with each other to improve how they are implementing PBL (high in the "colalboration" category). Qualitative responses from Science teachers support these data. A teacher described PBL "(when well implemented) to be very engaging and liberating for students. It [PBL] provides access points for students with a variety of needs and ability levels." Although there is some variability of perspectives within the department, these data suggest this teacher's perspective is consistent with that of the Science department overall.

Again, these data generally align with findings in the Exploratory Study #1. Students in the treatment group experienced gains in Science department AP coursework exams. Mean differences are statistically significant when accounting for matched students using GPA, SWD, and Gender as covariates. The Science department's CBAM data suggest department-wide adoption of PBL. For this analysis 620 comparison students were matched to 954 treatment students. Students in the comparison group were allowed to be matched to more than one treatment student making the weighted comparison and unweighted treatment groups to have 954 students each. AP Test Scores across all Science department

tests (Biology, Chemistry, Environmental Science, Physics-combined) for students in the treatment group (having taken at least one redesigned PBL course in any department) scored higher than the comparison group. As expected, departmental GPA (DepGPA) accounted for the vast majority of the variance in AP Test scores. While significant, PBL Exposure accounted for only a small portion of the overall departmental level variance especially as compared to Gender. One particular course (Biology) was responsible for the majority of the effects of PBL exposure in this department.

Table 32.

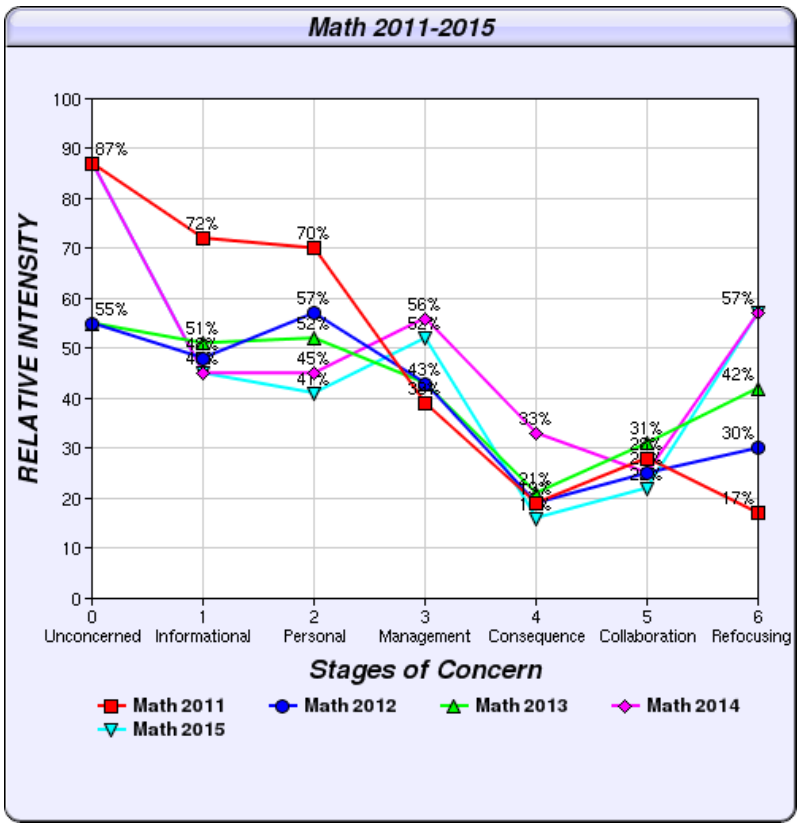
Dependent Variable: Advanced Placement Test Score (Science)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	786.906[b]	6	131.151	122.222	.000
Intercept	20.558	1	20.558	19.158	.000
DepGPA	486.690	1	486.690	453.555	.000
SWD	2.544	1	2.544	2.371	.124
ELL	9.004	1	9.004	8.391	.004
FRL	38.716	1	38.716	36.080	.000
Gender	94.563	1	94.563	88.125	.000
BigMatch	13.663	1	13.663	12.733	.000
Error	2039.879	1901	1.073		
Total	10721.000	1908			
Corrected Total	2826.786	1907			

a. Department = Science

b. R Squared = .278 (Adjusted R Squared = .276)

The Math Department. Chart 27 illustrates CBAM response data from the Math department from 2011 to 2015.



These data suggest teachers in the Math department remain hesitant to adopt PBL. The five year trend in their data suggest they 1) are concerned about PBL in general (resurgence in concerns in the "unconcerned" category), are concerned with how to manage it in their classrooms (high in the "management" category), and that 3) they are looking for other pedagogical models to implement (low in "collaboration" and tailing up in the "refocusing" category). The combination of their highest concerns reveal a "W" pattern in their data, especially in their 2015 responses. According to SEDL researchers, a "W" pattern suggests a group of people who have become disenchanted with the intervention and who are actively looking for alternatives they think would work better. According to one Math teacher, "Due to the amunt of new vocabulary and content needed in each course, longer in-depth, student led PBL problems have caused some problems in the past. The real world problems that we have tried to apply are either too oversimplified (so they aren't really real world any longer) or the realness (messiness of the data) obfsucates the purpose." Although teacher-level responses reveal some variation in teacher's perceptions about PBL, these data suggest this teacher's perspective is consistent with that of the Math department overall.

Agreement is clear between the CBAM data and our findings from Exploratory Study #1. Students in the treatment group experienced gains in Math department AP coursework exams. Mean differences are statistically significant when accounting for matched students using GPA as a covariate. The Math department CBAM data suggest the Math department has not fully adopted PBL. However, focus groups

conducted with the Math department suggest Math teachers, notably the AP Calculus teacher, has used the Key Elements of Problem Based Learning to inform how she continues to shape how students learn Calculus in her classroom. While the qualitative data suggest the Math department continues to approach what PBL looks like in their classrooms differently, they continue to use the Key Elements as guiding principles for how they further refine their course offerings.

For this analysis 476 comparison students were matched to 568 treatment students. Students in the comparison group were allowed to be matched to more than one treatment student making the weighted comparison and unweighted treatment groups to have 568 students each. AP Test Scores across all Math department tests (Calculus-combined, Statistics) for students in the treatment group (having taken at least one redesigned PBL course in any department) scored higher than the comparison group. As expected, departmental GPA (DepGPA) accounted for the vast majority of the variance in AP Test scores. While significant, PBL Exposure accounted for only a small portion of the overall departmental level variance especially as compared to Gender and FRL. However, when controlling for these covariates PBL Exposure was significantly associated with the outcome variable.

Table 33.

Dependent Variable: Advanced Placement Test Score (Math)

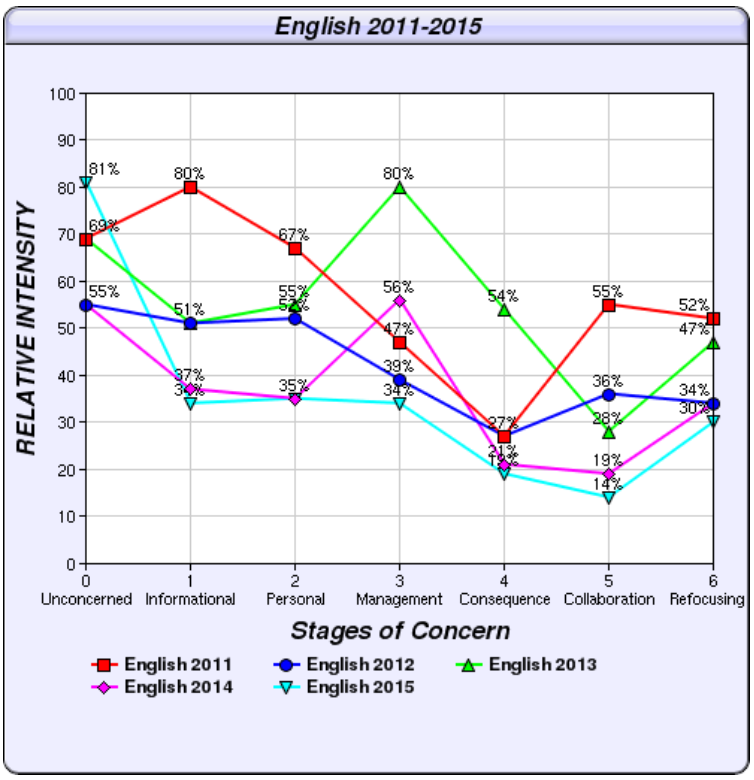
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1122.736[b]	6	187.123	134.309	.000
Intercept	98.922	1	98.922	71.002	.000
DepGPA	931.677	1	931.677	668.720	.000
SWD	.188	1	.188	.135	.714
ELL	1.341	1	1.341	.963	.327
FRL	9.271	1	9.271	6.654	.010
Gender	19.670	1	19.670	14.118	.000
BigMatch	9.304	1	9.304	6.678	.010
Error	1572.951	1129	1.393		
Total	10150.000	1136			
Corrected Total	2695.687	1135			

a. Department = Math

b. R Squared = .416 (Adjusted R Squared = .413)

The English Department. Chart 28 illustrates CBAM response data from the English department from 2011 to 2015.

Chart 28.



These data suggest teachers in the English department have become indifferent towards PBL and have abandoned it as a guding pedagogical model. The five year trend in the English department sugests they 1) remain concerned with PBL in general (resurgence in the "unconcerned" category), 2) are relatively unconcerned about either the management of PBL in their classrooms and uninterested in collaborating with colleagues to improve their implementation of PBL (decreases in the "management" and "collaboration categories), and 3) they are looking for other pedagogical models to use in their daily instructinal practice (tailing up in the "refocusing" category). Qualitative responses from English tecahers support these data. As one teacher stated, "The important skills that stuents need to learn get overlooked when only working on problems and activities. Many fundametal skills need practice in other methods." Although individual teacher's repsonses revealed some diversity within the department, these data suggest this teacher's perspective is consistent with that of the English department overall.

CBAM data showing a resistant department overall is consistent with our findings from Exploratory Study #1. Students in the treatment group did not experience gains on the AP English Language or AP English Literature exams. Mean differences are not statistically significant when accounting for GPA, SWD, and FRL as covariates. The English department CBAM data suggest the English department has abandoned PBL as a viable pedagogy for their content-area. Qualitative data suggest low PBL curriculum implementation fidelity.

For this analysis 629 comparison students were matched to 794 treatment students. Students in the comparison group were matched to more than one treatment student making the weighted comparison and un-weighted treatment groups to have 629 students each. AP Test Scores across all English department tests (English Language, English Literature) for students in the treatment group (having taken at least one redesigned PBL course in any department) did not score higher than the comparison group. As expected, departmental GPA (DepGPA) accounted for the vast majority of the variance in AP Test scores. PBL exposure accounted for nearly no variance in the outcome variable.

Table 34.

Dependent Variable: Advanced Placement Test Score (English)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	496.196[b]	6	82.699	87.481	.000
Intercept	39.028	1	39.028	41.284	.000
DepGPA	289.185	1	289.185	305.907	.000
SWD	10.012	1	10.012	10.591	.001
ELL	12.474	1	12.474	13.196	.000
FRL	30.016	1	30.016	31.752	.000
GEnder	1.668	1	1.668	1.765	.184
BigMatch	1.570	1	1.570	1.661	.198
Error	1494.576	1581	.945		
Total	12011.000	1588			
Corrected Total	1990.773	1587			

a. Department = English
b. R Squared = .249 (Adjusted R Squared = .246)

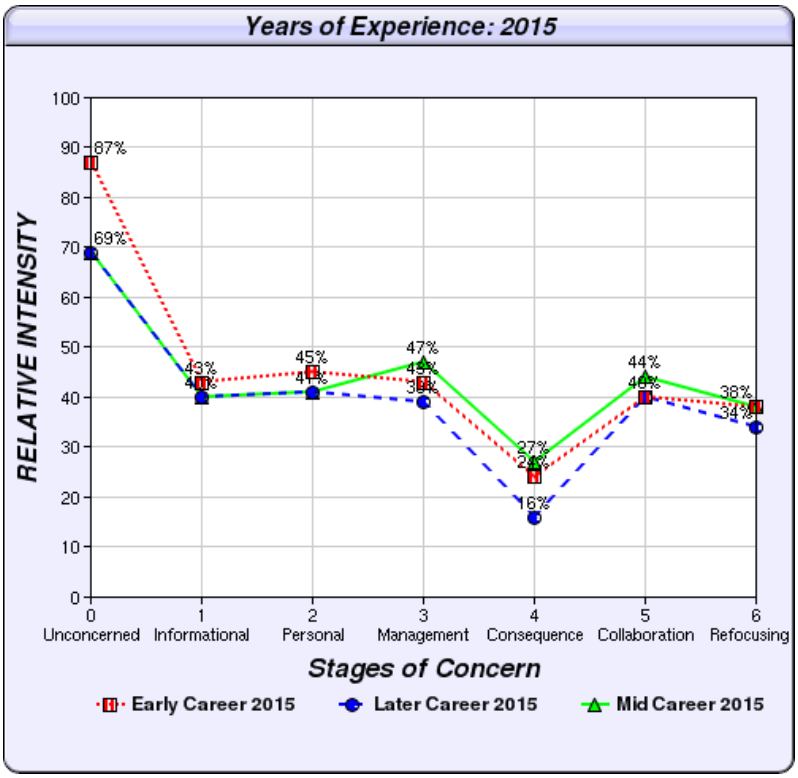
The World Language Department. Even though we do not share course level mean AP score data from the World Language department for reasons having to do primarily with small sample sizes, our findings show that students in the treatment group experienced gains in World Language department AP coursework exams. Mean differences are statistically significant when accounting for matched students using GPA, SWD, and EngNotFirst as covariates. The Foreign Language department's CBAM data suggest they have not fully adopted PBL. However, individual interviews conducted with World Language teachers suggest they actively look for ways to incorporate the Key Elements of Problem Based Learning into their teaching. While the qualitative data suggest the World Language department continues to approach what PBL looks like in their classrooms differently, they continue to use the Key Elements as guiding principles for how they further refine their course offerings.

Comparison of 2015 Data by Years of Experience and Department

Two prominent findings have emerged from the CBAM data. First, the CBAM data strongly suggests that departments and departmental membership influenced the extent to which teachers adopted PBL pedagogy. Second, the CBAM data also suggest that after five years the staff is somewhat divided around the central issue of PBL effectiveness.

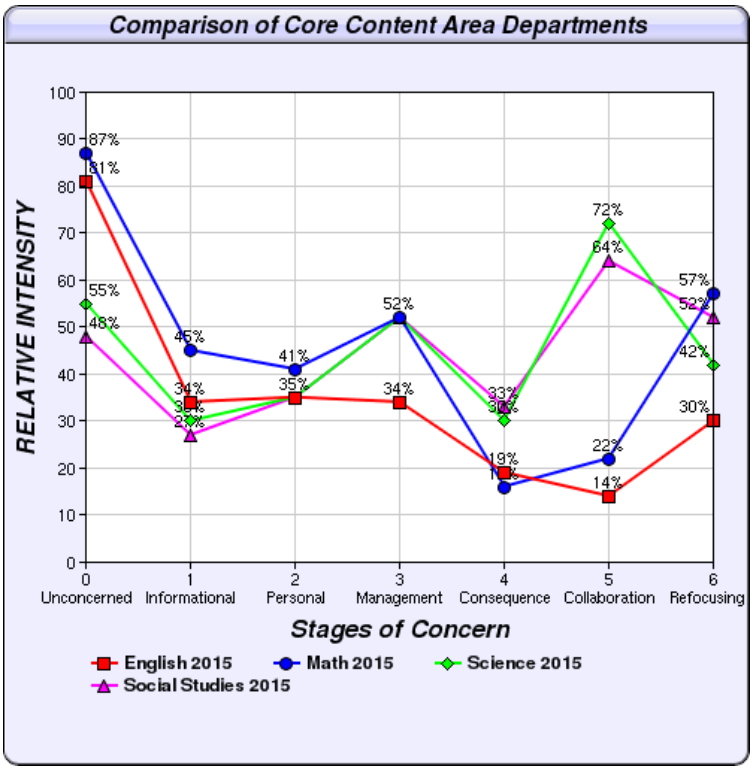
Data shared above illustrate both the diversity by which each department has adopted, or not, the PBL model of teaching and learning. The Math and English departments remain somewhat resistant, if not indifferent, to adopting PBL in their courses while the Science and Social Studies departments have successfully adopted PBL as the primary pedagogy in their courses. In Chart 29 below illustrating adoption curves by years of experience, it is clear there is no statistical difference between novice, experienced, and veteran teachers on the staff.

Chart 29.



This finding is surprising given conventional wisdom that holds that more veteran teachers would be more resistant to adopt a new pedagogical model. These data suggest there is little difference in concerns or adoption rates between less and more experienced teachers. Compare the Chart 29 with Chart 30 below in which we illustrate how departments compare in their adoption curves.

Chart 30.



When we compare PBL adoption rates by departments, the differences are more distinct. The most prominent difference between departments is the extent to which they perceive collaboration to be a primary concern at this point in the PBL project. The departments that are more concerned with collaboration, Science and Social Studies, are the departments that have fully adopted PBL pedagogy. Overall, departments who are adopting the intervention (PBL) see collaboration as an important tool to further refine their PBL design, thus making their ability to collaborate a major concern. Whereas the departments that are least concerned with collaboration, Math and English, are also the departments whose data "tail up" in the refocusing category, suggesting they are looking for other pedagogical models that might work better than PBL in their classrooms. Data illustrated in Figure 19 suggests that the core content area departments seem to be headed in different directions, potentially endangering the extent to which the school can sustain PBL as a guiding pedagogy across the school.

Comparison of Mean AP Scores by All Students Disaggregated by Department

Aggregated to the department level, the AP scores data shows gains in students mean AP scores between comparison and treatment groups in all departments. Students experienced statistically significant student gains in mean AP scores in the Math, Science, and Social Studies departments. Chart 31 compares the comparison and treatment group mean AP Scores by department.

Chart 31.

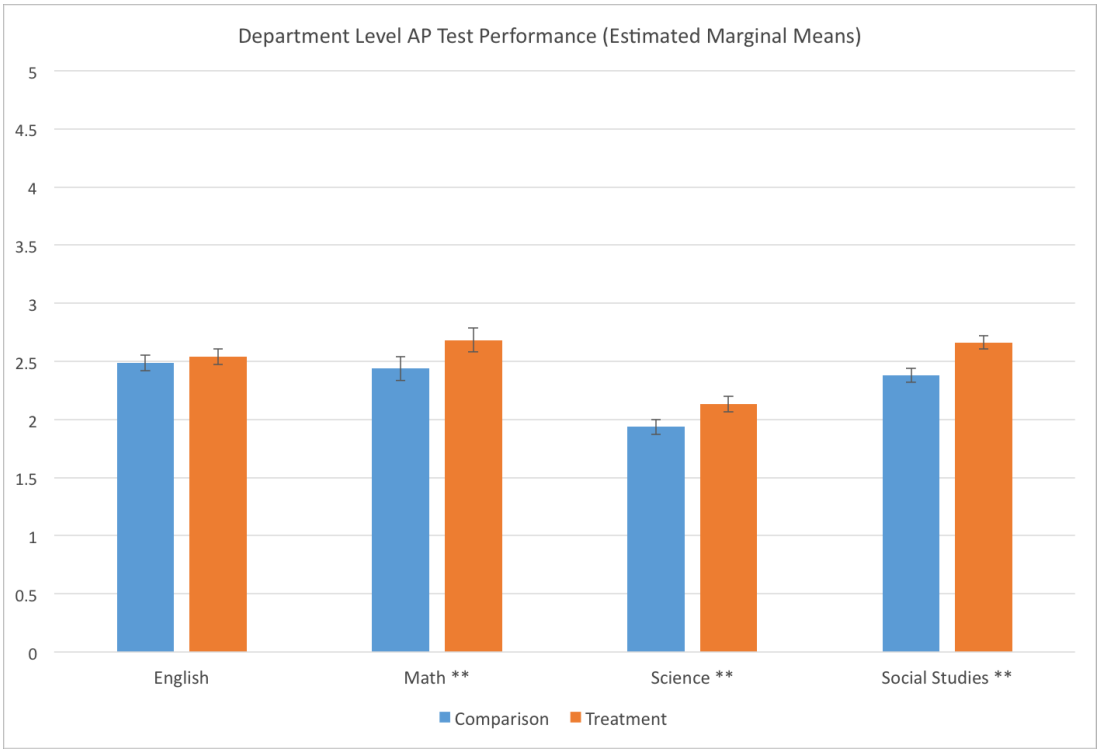


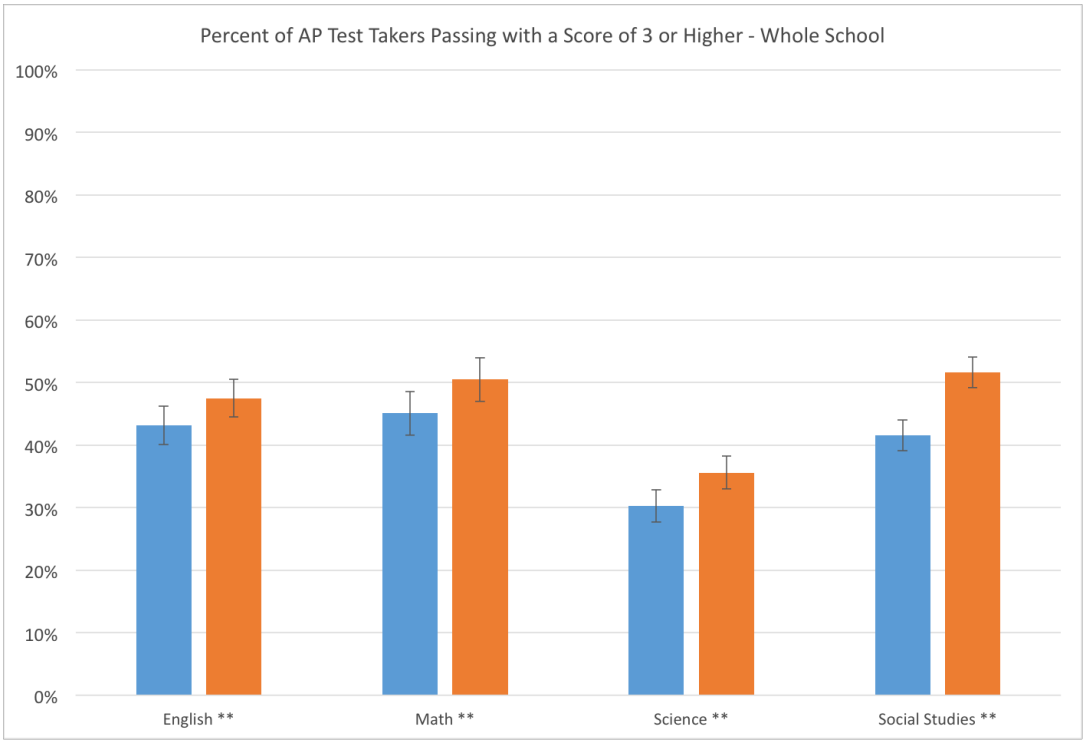
Table 35 below illustrates the statistically significant mean AP score differences between the comparison and treatment groups in departments.

Table 35.

Statistically Significant Gains in Mean AP Scores by Department	
Department	**Mean AP Score Difference**
Math	2.43 to 2.68
Science	1.93 to 2.13
Social Studies	2.37 to 2.66

Chart 31 below illustrates a similar positive trend in the percentage of students in each department who have passed AP tests. In the English (43% to 48%), Math (45% to 51%), Science (30% to 36%), and Social Studies (42% to 52%) departments, the difference in the percentage of students who passed AP tests was statistically significant.

Chart 31.



When we compare the mean AP scores in each department of students who receive free and reduced lunch (FRL) services, similar trends in the data emerge. While FRL students in the treatment group made gains in each department when compared to FRL students in the comparison group, the students in the treatment group made statistically significant gains in the Science and Social Studies departments. Chart 32 illustrates the gains made by FRL students in each department.

Chart 32.

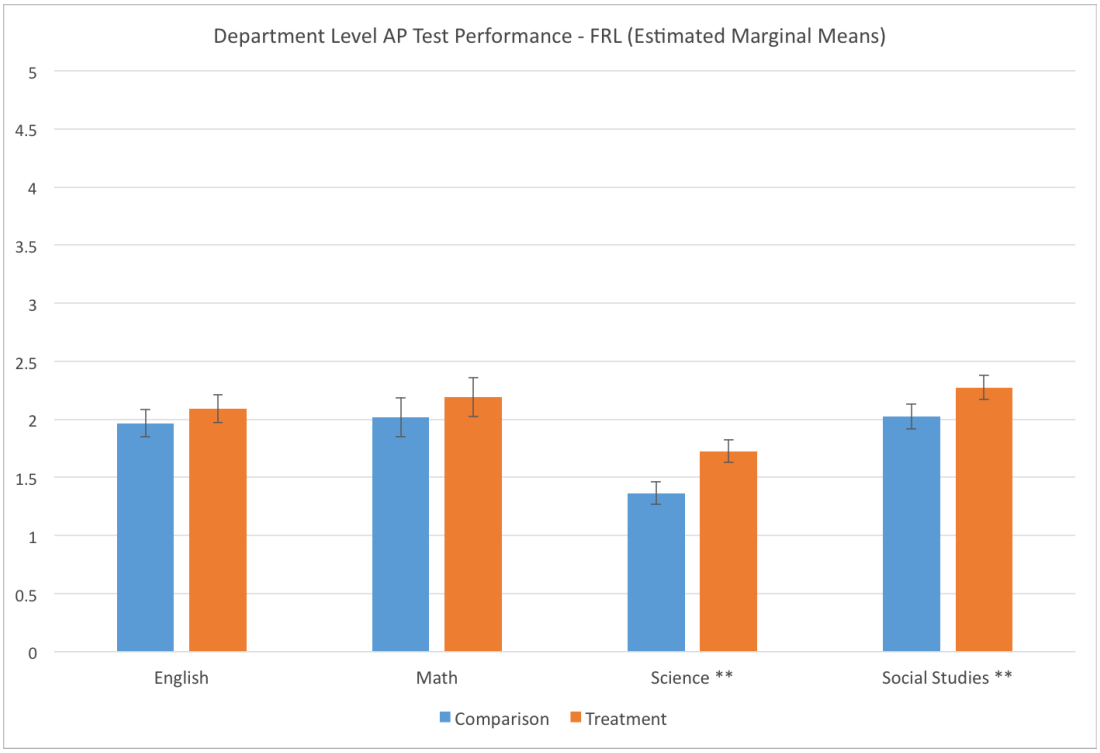


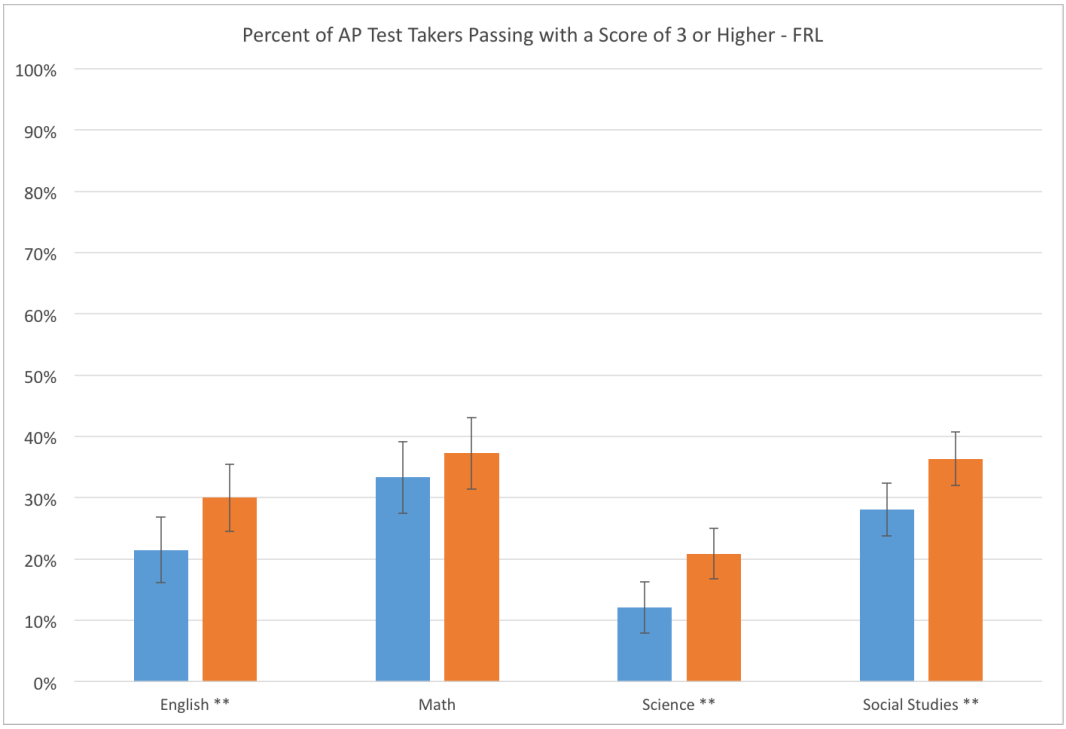
Table 36 below illustrates the statistically significant mean AP score differences between FRL students in the comparison and treatment groups in departments.

Table 36.

Statistically Significant Gains in Mean AP Scores by FRL Students by Department	
Department	**Mean AP Score Difference**
Science	1.36 to 1.72
Social Studies	2.02 to 2.27

Chart 33 below illustrates a similar positive trend in the percentage of FRL students in each department who passed AP tests. In the English (21% to 30%), Science (12% to 21%), and Social Studies (28% to 36%) departments, the difference in the percentage of students who passed AP tests was statistically significant.

Chart 33.



When we compare the mean AP scores in each department of students who speak a first language other than English at home (EngNotFirst), once again similar trends in the data emerge. While EngNotFirst students in the treatment group made gains in each department when compared to FRL students in the comparison group, the students in the treatment group made statistically significant gains in the Science and Social Studies departments. Chart 34 illustrates the gains made by EngNotFirst students in each department.

Chart 34.

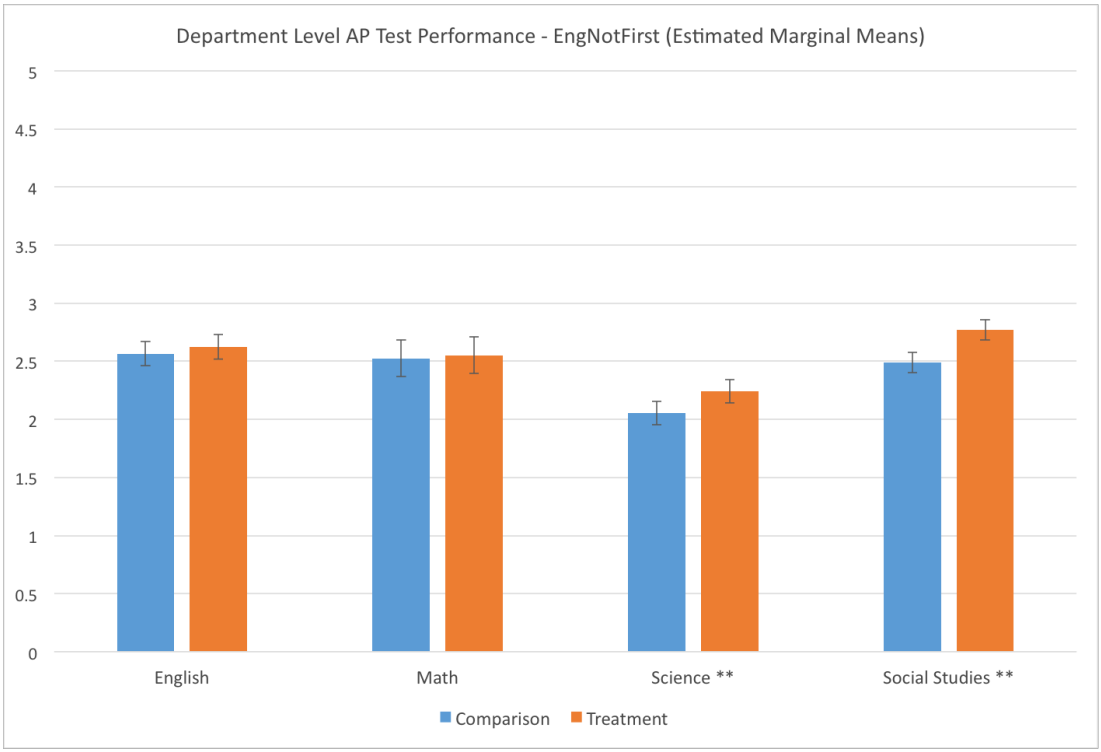


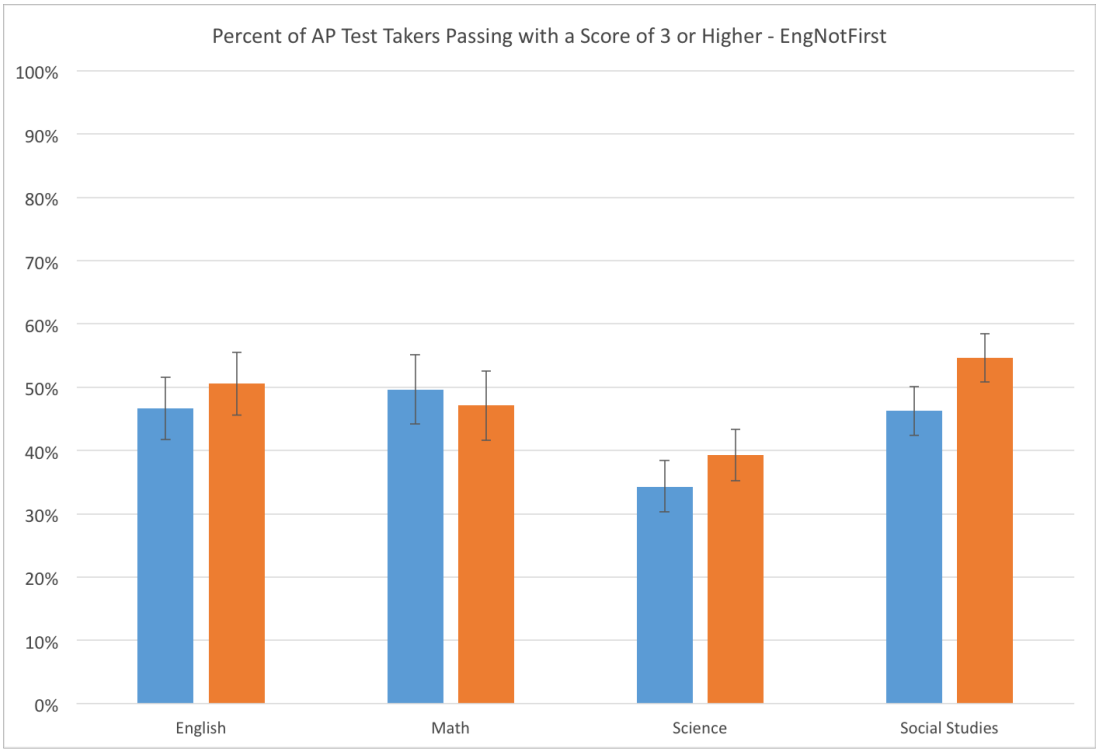
Table 37 below illustrates the statistically significant mean AP score differences between EngNotFirst students in the comparison and treatment groups in departments.

Table 37.

Statistically Significant Gains in Mean AP Scores by EngNotFirst Students by Department	
Department	**Mean AP Score Difference**
Science	2.05 to 2.24
Social Studies	2.49 to 2.77

Chart 35 below illustrates the percentage of EngNotFirst students in each department who passed AP tests. While the percentage of students who passed AP tests increased, with the exception of the Math department (50% to 47%), in no department were those increases statistically significant.

Chart 35.



When we compare the mean AP scores in each department of students with disabilities (SWD), students in the treatment group made gains in the Math, Science, and Social Studies departments when compared to SWD students in the comparison group. SWDs in the treatment group made statistically significant gains in Social Studies departments. Chart 36 illustrates the gains made by SWDs in each department.

Chart 36.

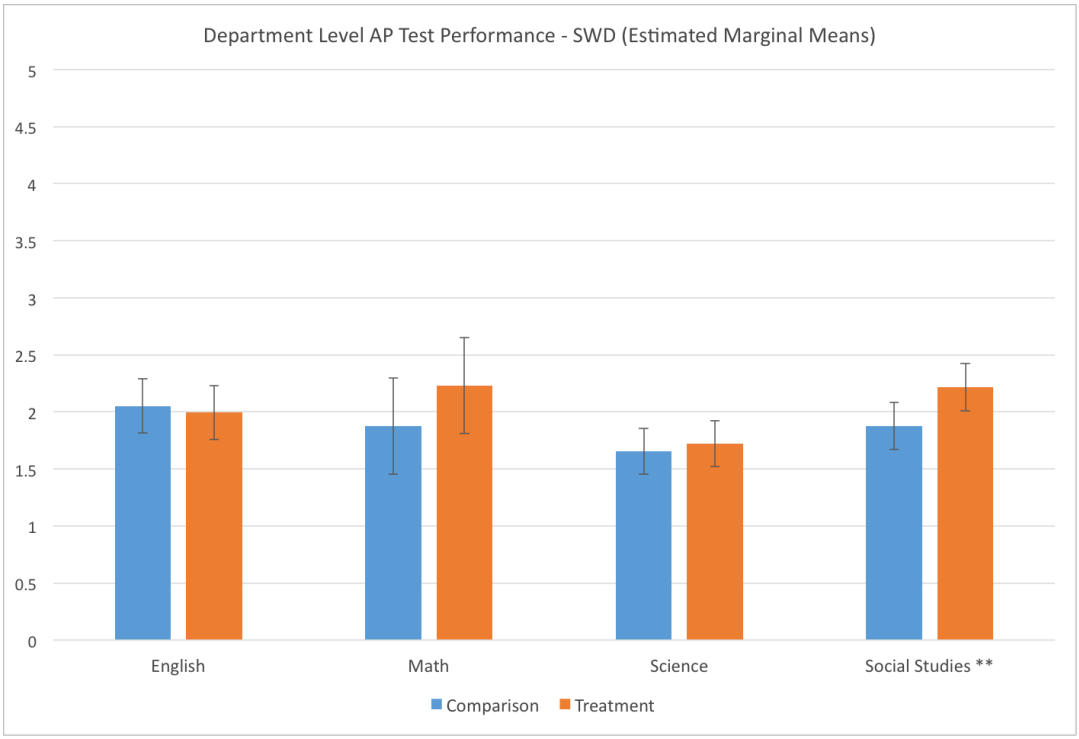


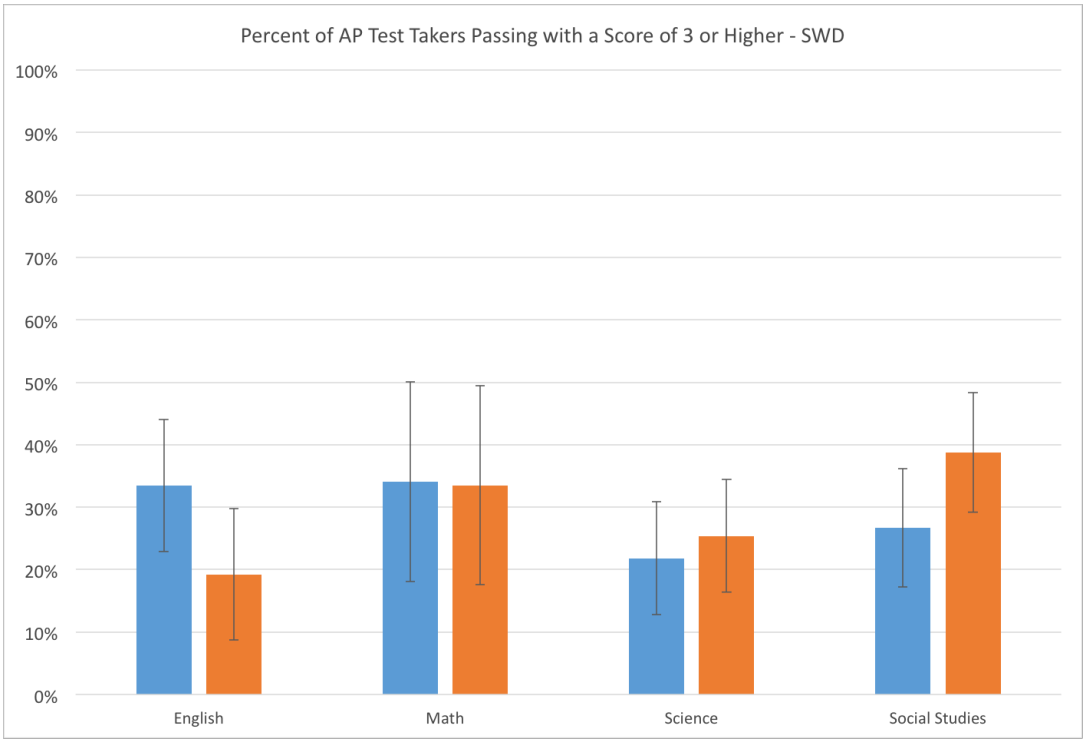
Table 38 below illustrates the statistically significant mean AP score differences between SWDs in the comparison and treatment groups in the Social Studies department.

Table 38.

Statistically Significant Gains in Mean AP Scores by Students with Disabilities (SWD) by Department	
Department	**Mean AP Score Difference**
Social Studies	1.87 to 2.21

Chart 37 below illustrates the percentage of SWDs in each department who passed AP tests. While the percentage of students in the treatment group who passed AP tests increased in the Science and Social Studies departments, those students passed AP tests at an equal rate in the Math department (34%) and passed AP tests at a decreased rate (34% to 19%) in the English department. In no department were those increases or decreases statistically significant.

Chart 37.

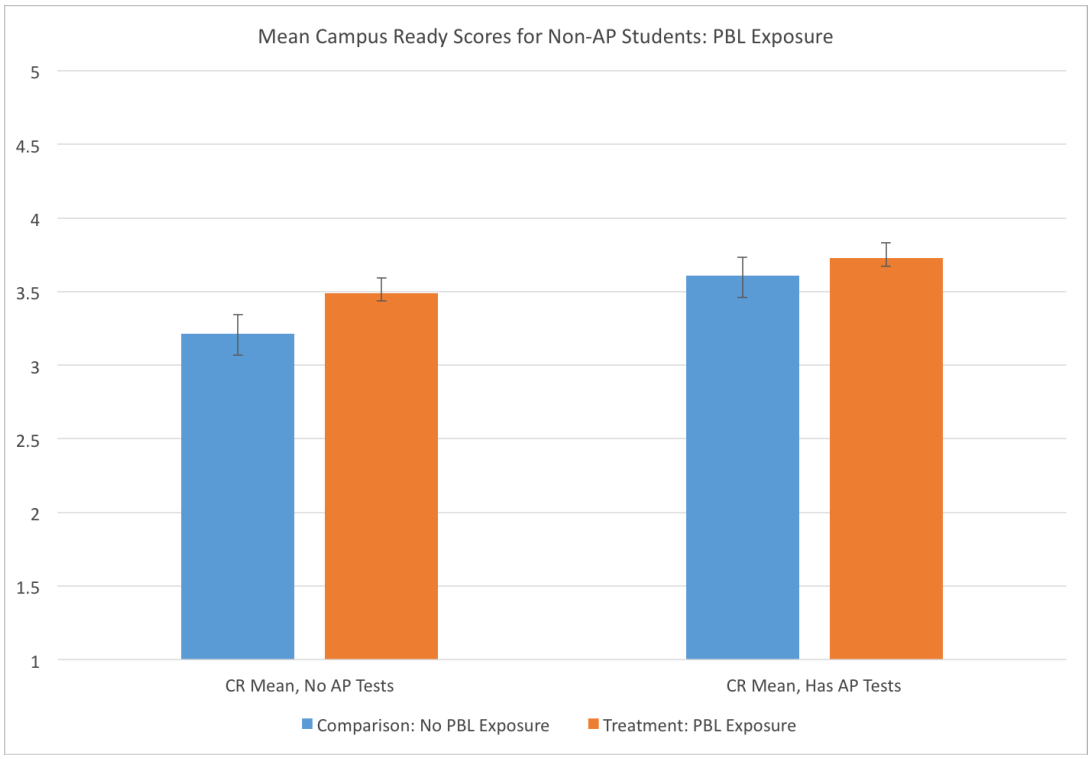


College and Career Readiness Outcomes for Students Not Participating in AP Coursework

So far we focus specifically on outcomes for students who enrolled in AP courses. Chart 38 includes outcomes for students not taking AP coursework on the Campus Ready assessment. The Campus Ready assessment is an externally validated assessment meant to measure students' career and college readiness as defined in the research (Conley, 2012). For the past four years, every Sammamish student took the Campus Ready assessment in the Spring of each academic school year.

Chart 38 compares mean Campus Ready assessment scores for students who had not taken AP tests with those who had taken AP tests. Within those two categories of students, we compare students who had no exposure to PBL coursework with those who had some exposure to PBL coursework. These data suggest that student outcomes on the Campus Ready assessment also improve for students who had not taken an AP test but who were exposed to PBL coursework.

Chart 38.


Mean Campus Ready Scores for Non-AP Students: PBL Exposure
5
4.5
4
3.5
3
2.5
2
1.5
1
CR Mean, No AP Tests
CR Mean, Has AP Tests
Comparison: No PBL Exposure
Treatment: PBL Exposure

Findings: Exploratory Study #2: Impact of Starting Strong/Sammamish Leads on Students' Career and College Readiness

The Starting Strong exploratory outcome study focused on the impact of participation in a PBL-oriented summer program on college and career readiness. The context for studying this impact is Starting Strong, an intense seven to nine-day summer program that uses a problem-based learning instructional model embedded with college and career readiness workshops. Starting Strong mirrors the curricular approach of the whole-school PBL curriculum redesign effort and thus provided a context to study the extent to which PBL as a broad instructional strategy might lead to changes in students' college and career readiness. The theory of change for Starting Strong is consistent with that of the larger i3 curriculum redesign effort. It is hypothesized that students who engage in authentic, collaborative problem-solving through partnerships with community and business organizations will score higher on measures of college and career readiness than students who do not experience this sort of curriculum.

The Dev07 project design consists 7 critical components (see fidelity section of this report) with Starting Strong as the 7th component: *Focusing on 1st Generation College Bound Students and Developing a PBL Laboratory: Starting Strong*. The rational for studying this component as a sub-study of the larger exploratory research is that:

1. PBL is the driving framework of Starting Strong
2. Expertise through partnerships provides the context and authentic problems for students to solve through collaboration
3. Starting Strong provides an exemplary picture of what full-blown PBL looks like
4. Starting Strong is a discrete 7 to 9-day intervention that lends itself to rigorous study
5. The faculty who teach in the Starting Strong program are also the teachers who are involved in PBL design and implementation of the high school curriculum
6. Most importantly, the central theme of Starting Strong is College and Career Readiness

For these reasons Starting Strong presented itself as an ideal proxy for studying the impact of the i3 project. In this study the evaluation sought to answer the following question:

- *Do students who participate in Starting Strong achieve higher levels of college and career readiness as compared to matched students who do not participate in Starting Strong?*

Methodology: Exploratory Study #2

This two-year study used a quasi-experimental design (QED) to study the impact of participation in the Starting Strong program on college and career readiness as measured by an instrument called Campus Ready. The design involved treatment students (those that participate in Starting Strong in one summer program) and a comparison group matched on a pre-administration of the Campus Ready instrument. Both treatment and comparison students in the study were drawn from the SHS population and were sophomores, juniors or seniors (Campus Ready pre-test data was not available for incoming freshmen). The study began with the pre-measure. (We use the concept of school year to maintain about when events occurred and use a two-year notation to signify the school year, for example, 'March, 2012-13'). Table 39 describes our data collection process for this study.

Table 39.

Date	Event
March, 2012-13	Campus Ready Administration (pre) for pool of students eligible for selection as treatment or comparison group member for the Starting Strong summer program offered in the summer of school year 2012-13.
Summer, 2012-13	Starting Strong Participation (first cadre) and evaluation of fidelity.
March, 2013-14	Campus Ready Administration (pre) for pool of students eligible for selection as treatment or comparison group member for the Starting Strong summer program offered in the summer of school year 2013-14.
March, 2013-14	Campus Ready Administration (post) for Starting Strong participants from the previous school year (2012-13). Those students who had both pre and post Campus Ready data at this time and who participated in the 2012-13 Starting Strong program defined cadre 1 of the treatment group. The remaining students having both pre and post-test Campus Ready data and no participating in any Starting Strong summer program comprised the matching pool set 1 of comparison students.
Summer, 2013-14	Starting Strong Participation (second cadre) and evaluation of fidelity.
March, 2014-15	Campus Ready Administration (post) for Starting Strong participants from the previous school year (2013-14). Those students who had both pre and post Campus Ready data at this time and who participated in the 2013-14 Starting Strong program and who did not participate in the 2012-13 Starting Strong summer program defined cadre 2 of the treatment group. The remaining students having both pre and post-test Campus Ready data and no participating in any Starting Strong summer program comprised the matching pool set 2 of comparison students.
Summer, 2015	Campus Ready data acquired for all students
	Treatment group finalized (cadres 1 and 2 combined that meet treatment group inclusion criteria)
	Comparison group finalized from comparison pool (sets 1 and 2 combined) that meet comparison group inclusion criteria.
	Data Analysis

Using Shaddish, Cook and Campbell notation, the design of the study is:

$$\begin{array}{llll} NR & O_1 & X & O_2 \\ \text{----------} & & & \\ NR & O_1 & & O_2 \end{array}$$

O_1= Pretest (Campus Ready) used for matching and to check baseline equivalency at study conclusion
X = Treatment (Participation in 2 consecutive Starting Strong programs)
O_2= Posttest (Campus Ready) used to determine performance levels

Subjects

Students eligible for the study included those that participated in Starting Strong during the summers following school years 2012-13 and 2013-14. For those attending the 2012-13 program their Campus Ready scores during that same school year (5 months before attending Starting Strong) served as their pretest and their 2013-14 Campus Ready scores (7 months after attending Starting Strong) served as their post-test. The group of students who attended the next year summer program followed the same pattern but a year later for pre and post tests. All pre-test values were pooled and defined the pool from which treatment students were selected. The treatment group, then, had students in cohorts 2010, 2011, and 2012. Only students with both pre and post Campus Ready data were included in the final treatment group. 107 students were eligible for the treatment group before checking for double doses of Starting Strong. After removing students that had attended both summers to the total number of students in the treatment group was 95.

Comparison students were drawn from the same cohorts as the treatment group students and had to have pre and post Campus Ready data available but not attended Starting Strong at any time (N = 237).

Matching

A simple one-to-one matching strategy was utilized. Students in the treatment group were matched to students in the comparison pool using Cohort (i.e., the school year of their freshman enrollment at SHS) and their scored on the Campus Ready pre-test. This matching strategy controlled for years of education and SHS and exposure to PBL courses since each cohort should have the same opportunity to take courses at SHS.

All students with pre and post-test data were divided by cohort and then within each of these cohort groups, were separated by treatment or comparison participants. Campus Ready scores were then rounded to 0.25 standard deviations of the pooled group pre-test mean and treatment students in each cohort group were sorted by pre-test score: high to low. Similarly, comparison students in each cohort group were randomized and then sorted on pre-test from high to low. Comparison students were then matched to treatment students using the rounded pre-test score. The first comparison student to match exactly was kept, the remaining matches discarded. Once all matches were made in each cohort group the cohort treatment groups were combined and the cohort comparison students were combined. A dummy variable called GroupF was created and each comparison members was coded as zero while each treatment student was coded as one. Students in the comparison pool were matched to all 95 treatment students with 5 comparison students being matched to 2 treatment students.

Outcome Variable

The pre-test (Campus Ready developed and validated by EPIC) was used to match comparison students to Starting Strong students, and the post-test was used to examine differences on the outcome variable (college readiness) between these groups. Campus Ready was administered to SHS students each

March of the five-year project period. Campus Ready measures the following constructs related to college and career readiness:

- Key Cognitive Strategies – patterns of intellectual behavior that lead to higher order thinking
- Key Content Knowledge – knowledge and attitudes toward the core subjects needed for success
- Academic Behaviors – attitudes and behaviors for success in college and workplace
- Contextual Skills and Awareness (College Knowledge) – knowledge and skills necessary to apply and enroll in college/navigate higher education

A total score was computed by summing weighted scores from these dimensional sub-scores. Data were available for students at the sub-scale level (means and standard deviations have been provided). These data are treated as continuous variables. Table 40 below lists the dimensions, aspects, and components of this instrument.

Table 40.

Dimension (Key)	Aspect	Component
Key Cognitive Strategies (weight = 5)	Problem Formulation	Hypothesize
		Strategize
	Research	Identify
		Collect
	Interpretation	Analyze
		Evaluate
	Communication	Organize
		Construct
	Precision/Accuracy	Monitor
		Confirm
Key Learning Skills & Techniques (weight = 2)	Self-Monitoring	Goal-Setting Strategies
		Persistence Strategies
		Self-Awareness Strategies
	Learning Strategies	Test-Taking Strategies
		Note-Taking Strategies
		Information Retention Strategies
		Collaborative Learning Strategies
		Time Management Strategies
		Strategic Reading Strategies
		General Study Strategies
Key Transition Knowledge & Skills (weight = 4)	Academic Awareness	College and Career Preparation
		College and Career Expectations
	College Admissions Process	College Selection
		College Application
	College and Career Culture	College Awareness
		Career Awareness
	Tuition and Financial Aid	Financial Aid Awareness
		Tuition Awareness

Key Content Knowledge (weight = 5)	Academic Attribution	ELA Attribution
		Math Attribution
		Science Attribution
		Social Sciences Attribution
		Technology Attribution
	Academic Value	ELA Value
		Math Value
		Science Value
		Social Sciences Value
		Technology Value
	Student Effort	ELA Student Effort
		Math Student Effort
		Science Student Effort
		Social Sciences Student Effort
		Technology Student Effort
	Challenge Level	ELA Challenge Level
		Math Challenge Level
		Science Challenge Level
		Social Sciences Challenge Level
		Technology Challenge Level
	General Key Content Knowledge	Structure of Knowledge
		Experience with Technology

The developers of the Campus Ready instrument used a four-part model to establish validity and reliability: factor analysis, discriminant analysis, item reliability, and think-alouds. The factor analysis yielded a 5-factor solution consistent with the four dimensions of the instrument (All dimensions except the Learning Strategies discriminated at an acceptable level between high and low performing schools. Reliability coefficients were found to be at 0.88 or higher suggesting a high degree of internal consistency. The think-alouds are in progress and data is not yet available. (More information on the Campus Ready instrument is available from the developer.)

Statistical analysis of outcomes for students

After data from the final Campus Ready assessment are available we will check the remaining treatment and comparison groups for baseline equivalency. If pooled average standard deviation on the Campus Ready pre-assessment is less than or equal to .25 then the matches will remain intact. If, however, this value is greater than .25 SD then comparison students will be rematched to treatment students.

Analysis

An analysis of covariance using the GLM function in SPSS was used to analyze data. GLM Univariate allows one to model the value of a dependent scale variable based on its relationship to dicotymous categorical and scale predictors. The categorical factor for prediction was the independent variable: participation/no participation in Starting The dependent variable was individual student scores on EPIC Campus Ready instrument. Covariates included the pre-score on Campus Ready, FRL, and ELL, and Parent Education. No missing Campus Ready data were imputed. Statistical model:

$$\text{PostCR Score}_i = \beta_0 + \beta_1(Condition) + \beta_2(\text{PreCR}) + \beta_3(\text{ELL}) + \beta_4(\text{ParentEd}) + \beta_5(\text{SES}) + \epsilon_i$$

Results

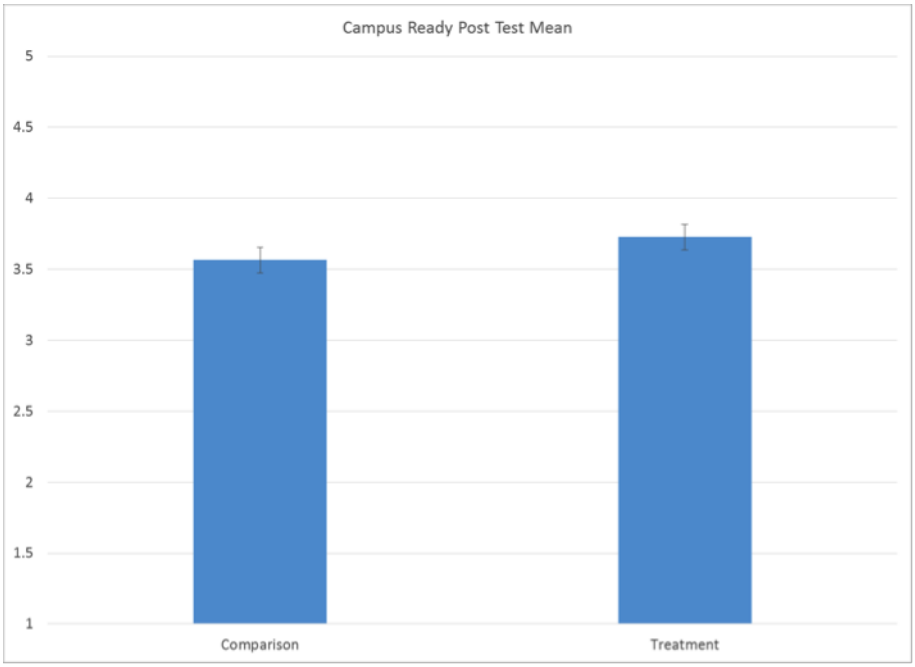
The pre-test scores for the comparison and treatment group are nearly equal as are standard deviations. The differences between the estimated marginal post-test means is .1.64 or about third of a standard deviation (p=.013).

Group	Pre-Test Means	N	Std. Deviation
Comparison	3.5888	95	.55321
Treatment	3.5929	95	.55288
Total	3.5908	190	.55158

Group	Estimated Post-Test Means	N	Std. Error
Comparison	3.563	95	.046
Treatment	3.727	95	.046

In the model the covariate accounts for the bulk of variance in the outcome variable is the pre-test score and a small amount by the dependent variable. Chart 39 below illustrates gains by treatment (Starting Strong students) on the Campus Ready instrument. However, their gains are not statistically significant.

Chart 39.



Tests of Between-Subjects Effects

Dependent Variable: Post Campus Ready Score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared

Corrected Model	28.152	5	5.63	27.832	0	0.431
Intercept	5.79	1	5.79	28.623	0	0.135
Pre-Test	26.459	1	26.459	130.791	0	0.415
ELL	0.031	1	0.031	0.151	0.698	0.001
Parent Education	0.006	1	0.006	0.03	0.863	0
FRL	0.055	1	0.055	0.271	0.603	0.001
Treatment	1.265	1	1.265	6.254	0.013	0.033
Error	37.223	184	0.202			
Total	2589.399	190				
Corrected Total	65.375	189				

a. R Squared = .431 (Adjusted R Squared = .415)
b. Computed using alpha = .05

Discussion

Quantitative analysis of matched groups reveal gains in student performance on the Campus Ready instrument. Observations of multiple Starting Strong/Sammamish Leads modules evidence strong student engagement, collaboration, and active problem solving. A member of the research team observed a student focus group held on the last day of the Bill and Melinda Gates Foundation World Health challenge. In this module, students were challenged with identifying a specific problem within the realm of global health, such as maternal care and availability of vaccines in the Third World. Students described their experience as both interesting and empowering. Specifically, they focused on the opportunity to work with a Global Health specialist from the Bill and Melinda Gates Foundation throughout the module as very positive for their motivation to engage the problem and find a solution with peers. When the evaluation team interviewed the teacher, she highlighted student choice and problem authenticity as major contributors to students' overall engagement and interest.

Although the quantitative data suggest little impact of Starting Strong/Sammamish Leads on students' performance on the Campus Ready instrument, those data do not fully describe the value students seem to see in the Starting Strong/Sammamish Leads experience. Our observations revealed high levels of student creative and collaborative problem solving. Students work alongside industry experts to think deeply about chronic problems and possible solutions to them. In most cases, students present their solutions to a panel of industry experts and answer tough questions from them about the practicality and viability of their solutions. These unique experiences should not be overlooked, especially for students who will be the first in their family to go to college. Our observations suggest that what students learn from their experience in this program augments and accentuates the PBL experience they receive in their coursework throughout the year.

Lastly, Starting Strong/SHS Leads served as an important PBL laboratory for the school, especially in how the program deepened teachers' expertise in PBL pedagogy and practice. Over time the program proved useful not just for deepening students facilities with key 21st Century skills but in providing teachers with experience in teaching in a PBL context with no constraints. Teachers gained valuable experience working with experts to plan highly engaging and relevant PBL experiences and coaching students on collaborative and problem-solving strategies without the constraints of grading, high stakes testing, or district curriculum or common assessments to worry about. This proved liberating for teachers

and students alike and seemed to free teachers to take greater risks in how they planned their challenges and freed students to fail while trying something new.

Chapter 7: Discussion and Conclusions

Sammamish High School implemented the intervention (PBL) with high fidelity in almost every facet of the project, despite the inevitable shift in priorities that occur over time. Several critical components emerged from this project that provide the background for student gains on AP tests. The most important of these is the development of the Key Elements of Problem Based Learning framework that guided all curriculum redesign efforts and all professional learning experiences. The Key Elements framework also provided Sammamish High School teachers, school leaders, and students a common language to describe and define ambitious teaching and learning practices. Interviews and focus groups with teachers, school leaders, and students repeatedly revealed a working knowledge and understanding of the Key Elements as a whole and with what enactment of specific Key Elements looks like in the classroom. This emerging common language around PBL can be directly attributed to the robust infrastructure of professional learning developed by teacher leaders and the principal working on the Leadership Team. The Key Elements framework provided a foundation for virtually every i3 project associated policy implemented in the past five years, profoundly shaping a shift in how teachers taught and how teachers and students learned.

The redesigned school Leadership Structure had some impact on the overall success of the project. They partnered with existing teachers to design professional learning experiences a vast majority of teachers described as valuable overall and relevant to their specific classroom practice. Teacher led- and designed SILT professional learning experiences complimented the work teachers were doing in design teams. Design teams proved especially powerful contexts for teacher learning. While not every design team was equally successful in their efforts to design PBL curriculum, nearly every teacher felt the design team experience was one of the most valuable in their careers. In many cases, teachers' creative and collaborative problem solving, focused on student learning and problems of practice, made teachers feel like valued professionals within the school.

Overall, students who experienced PBL curriculum in their AP coursework improved their scores on AP tests when compared to students who took the same or similar AP coursework before the school implemented PBL across content areas. Even though it would be premature to suggest a causal relationship between PBL AP coursework and improved student scores on AP tests, the data suggest that PBL curriculum does not hurt student performance on AP exams. Rather, data from Sammamish High School suggests that the school's PBL implementation positively impacted students' college and career readiness outcomes overall, specifically their performance in AP coursework and their performance on the Campus Ready assessment. While students who speak a first language other than English at home (EngNotFirst) experienced gains in some mean AP scores, qualitative data suggest that ELLs continue to struggle with the language and pedagogical demands inherent in a PBL classroom.

While findings indicate Sammamish High School students achieved statistically significant, wide spread gains in AP scores across many AP tests in the English, Math, Science, and Social Studies departments, they also obscure variability in how departments interacted with the PBL initiative throughout the duration of the grant. Quantitative and qualitative findings suggest that the academic departments at Sammamish High School played an important, possibly central role, in the extent to which individual teachers adopted PBL.

Results from the Concerns Based Adoption Model (CBAM) surveys show varied levels of adoption of PBL throughout the school. In those departments where a vast majority of teachers adopted

PBL as a guiding pedagogical model, PBL seems to have augmented practices and routines already in place. This finding is especially pronounced in the Social Studies department where Levels of Use (LOU) interview data suggest several teachers had experience developing PBL curriculum and where the department already had a strong collaborative culture in place that aligned with the collaborative work teachers would do in design teams. In those departments where PBL has not gained widespread traction, such as the English department and to a lesser extent in the Math department, PBL seemed to present a significant pedagogical disruption to teaching "business as usual." Although department level CBAM data suggest the English department has all but abandoned PBL as a guiding pedagogical model, both the teacher level CBAM data and interview data suggest that outlier English teachers remain open to the potential PBL provides to engage more students. While PBL has made few in roads into how the Math department designs and implements new curriculum, qualitative data suggest they use the Key Elements to inform how they continue to adjust and rework the existing curriculum. In almost every case, the extent to which departments have adopted PBL closely aligns with the extent to which department leadership have come to accept and promote PBL as a legitimate pedagogy and one that can have potentially positive impacts on student learning outcomes.

Course level findings illustrated above suggest design team teachers may be transferring knowledge gained in their design teams to courses that were not redesigned into PBL courses. Statistically significant gains in AP Calculus and AP Psychology are two good examples. Both the AP Calculus and AP Psychology courses were not formally redesigned through funds from the i3 grant. However, in the past 4-5 years, teachers who have design team experience have been teaching the AP Psychology course. Additionally, AP Calculus teachers are renowned for using highly student-centered practices, many of which are described in the Key Elements. Even though the AP Calculus course has not been redesigned, a long-standing AP Calculus teacher described to us how she uses the Key Elements to inform how she plans and adjusts her curriculum throughout the year. While not statistically significant, AP English Literature, AP English Language, and AP Statistics are three courses that have not been redesigned but where students have also experienced gains in mean AP scores. Teachers also benefitted from exposure to high quality professional learning a vast majority of which focused on student-centered, PBL pedagogy and strategies. Over time teacher participation in SILT and design teams seemed to deepen their pedagogical and pedagogical content knowledge expertise.

Starting Strong/Sammamish Leads, although not as impactful on standardized measures, made qualitative impacts on how Sammamish students approached learning. Students attend Starting Strong/Sammamish Leads during the summer and get to choose what module they attend. Students work collaboratively, many times with an industry expert, to solve ill-defined, complex problems. The experience they gain hones their ability to think creatively and divergently, work collaboratively with peers, and gain valuable experience working on an authentic task in a profession, field, or discipline. This experience is especially valuable for students who would be the first in their family to attend college as it expands their career options and may provide them with purpose as they navigate the college landscape.

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Appendix A. Implementing PBL Classroom Observation Protocol

Date:
Start time: **End time:**
Period/Class:
Observer:
Teacher:
What is the goal or objective of this lesson?
How is this lesson contextualized within a larger unit?
Briefly describe (3-5 sentences) what happened during this lesson.

	Teacher						Individual student						Groups of students							Page_____
Time	**Instructions**	**Lecture**	**Modeling**	**Answering**	**Coaching**	**Other**	**Seatwork**	**Computer**	**Presenting**	**Mentoring**	**Lab work**	**Other**	**Partner work**	**Group work**	**Computer**	**Presenting**	**Critiquing**	**Lab work**	**Other**	**Notes**

	Teacher						Individual student						Groups of students							Page_____
Time	Instructions	Lecture	Modeling	Answering	Coaching	Other	Seatwork	Computer	Presenting	Mentoring	Lab work	Other	Partner work	Group work	Computer	Presenting	Critiquing	Lab work	Other	Notes

	Teacher						Individual student						Groups of students							Page_____
Time	Instructions	Lecture	Modeling	Answering	Coaching	Other	Seatwork	Computer	Presenting	Mentoring	Lab work	Other	Partner work	Group work	Computer	Presenting	Critiquing	Lab work	Other	Notes

Appendix B: Key Element Classroom Observation Protocol

Date:
Start time: **End time:**
Period/Class:
Observer:
Teacher:

NOTE: As you complete this table, please refer back to the Key Elements SHS document for clarification on the Key Elements.

KEY ELEMENT	FOCUS QUESTIONS	OBSERVATION EVIDENCE	CONTINUUM LEVEL OBSERVED					
Authentic problems	*What is the problem/project? *Is the problem/project relevant to the professionals in the community? *Do students have input on the crafting of the problem/project? *How structured is the problem? *Are there more than one possible solutions and strategies for addressing the problem/project?		N.O.	INC	INT	TRAN	EMP	N.O.C.
Developing expertise	*Is knowledge or expertise opening shared across the project team (including students, teacher, and industry professionals? *Do facilitators (teachers or industry professionals) elicit student expertise? In what context? How frequently? *What types of expertise show up in the setting (e.g. school-related or hobby		N.O.	INC	INT	TRAN	EMP	N.O.C.

	related)? *How is feedback given in the setting?							
Culturally responsive instruction	*Does it appear that the teacher has taken time to learn about students and their interests outside of school? *Is the lesson connected to local issues and/or issues relevant to students' lives? *Are examples and experiences from a variety of cultures and life experiences used to illustrate the power of the discipline and/or project? *Does the lesson capitalize on students' native language and values? *Does the teacher inform students of the ways in which their native language and values may differ from the language and values of the workplace and higher education?		N.O.	INC	INT	TRAN	EMP	N.O.C.
Student voice	*Is student feedback elicited? If so, how? *Do all students give feedback or do some students give feedback more often? *Do students have a say in how the lesson progresses, how the work happens and how it is managed?		N.O.	INC	INT	TRAN	EMP	N.O.C.
Collaborative groups	*How is group collaboration set up at the beginning of the lesson? *Does this dynamic		N.O.	INC	INT	TRAN	EMP	N.O.C.

	continue throughout the lesson? *Are students collaborating within groups? How? *How do facilitators support collaboration? *How are roles defined and established in the group? *Does it appear that students are aware of the importance of collaboration for college and career readiness?							
Academic discourse	*How are academic and discipline-specific vocabulary taught or addressed in the project work? *Do students uptake and use vocabulary specific to the discipline? How? *What happens when students are confused or stuck on discipline-specific vocabulary?		N.O.	INC	INT	TRAN	EMP	N.O.C.
Authentic assessment	*How is assessment present in this lesson? *Are students assessed in a way that is representative of a profession aligned with the discipline of the class?		N.O.	INC	INT	TRAN	EMP	N.O.C.

Key:
N.O. = Not observed
INC = Inclusion
INT = Integration
TRAN = Transformation
EMP = Empowerment
N.O.C. = Not on continuum

Appendix C: Levels of Use (LOU) Teacher Interview Protocol

Working knowledge of innovation:

1. Describe how you think about the relationship between the Key Elements and PBL? Are they one and the same or do you think of them as distinct pedagogies and/or strategies?

2. Describe your current familiarity with the Key Elements specifically and with PBL generally?

Using the innovation:

3. In what ways have you incorporated the Key Elements into your teaching practice?
    - When you incorporate the Key Elements into your practice, would you say you depend heavily on the description of specific elements in the Key Element document or do you make changes based on your own understanding of what those pedagogical strategies are?

4. What challenges have you encountered as you have worked to incorporate the Key Elements into your teaching practice?
    - Are there ways you think the Key Elements and/or PBL don't work for your classroom or content area? How?

5. If you were to imagine a spectrum of your own teaching over time, on the left is how you taught before the grant work started and on the right is full blown implementation of the Key Elements and PBL, where would you put your practice on that spectrum today?
    - Why?
    - Do you have a specific example regarding assessment, student collaboration, to further illustrate your response?

Coordinated use of innovation:

6. In what ways have you worked with colleagues to further refine how you implement the Key Elements in your classroom?

7. Has your thinking about teaching changed at all as a result of your collaboration with other teachers?

Adaptation of innovation:

8. As you continue to work with the Key Elements, have you started adapting/changing what PBL looks like for your specific classroom and students?

9. Can you foresee a time in the future when you would revise, change, or abandon the Key Elements or PBL for something better or different?