

TISS: A Summary of Findings on Program Impacts

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TISS: A Summary of Findings on Program Participant Impacts

Launched in 2008 in tandem with the opening of the completely renovated California Academy of Sciences facilities, the [Teacher Institute on Science and Sustainability \(TISS\)](#) was designed as an immersive, two-year professional development program for third to fifth grade teachers. This program focused on increasing scientific and sustainability literacy, with the goal of increasing the quantity and quality of science teaching and learning in the classroom. By focusing on sustainability and the science behind sustainability, TISS provided a relevant and accessible entry point for teachers who may be intimidated by science. By interacting with the teachers for an extended period of time, TISS followed best practices and moved beyond one-off professional development workshops for teachers. As research has shown, professional development needs to be intensive, ongoing, collaborative, and aligned with school improvement priorities and goals to make a lasting impact on teachers (Darling-Hammond et al., 2009).

TISS staff models good teaching practices and provides individualized and team coaching. External evaluations by Rockman et al and SRI International have documented that teachers:

- have enjoyed and valued the program
- felt it filled an important need for inquiry and sustainability-oriented professional development not otherwise available
- believed they learned valuable science content and pedagogy
- felt they did more and better science instruction as a result, and
- saw greater student engagement in the classroom

Additionally, many teachers have expressed to evaluators that TISS is the best professional development experience of their careers (Burg et al., 2010; Montell et al., 2010; Hazer et al., 2012; Michalchik et al., 2012).

Since 2012, a team of researchers from SRI International's Center for Technology in Learning has served as developmental evaluators to the TISS program, studying teacher experiences in the program and their subsequent impacts on science teaching identity, confidence, competence, reflection, and collaboration. What follows is a summary of findings on TISS's impacts on its teacher participants.



Cohort 5 Interviews

SRI conducted interviews with Cohort 5 teachers over the course of their two years in the TISS program (2013-2015) to better understand their experiences. Teachers provided evaluative feedback on TISS program components, reported on their use of TISS tools, and spoke to how the program affected their teaching practice.

Cohort 5 teachers experienced significant growth as a result of their two years of participation in TISS. The most consistent impacts teachers reported were:

- an increase in confidence and comfort with science
- moving towards more student-directed science lessons
- appreciation and growth stemming from the collaborative nature of TISS
- the forming of goals to more effectively incorporate NGSS practices in their classrooms
- empowerment to adapt the science curriculum they were given by schools
- deeply valuing coaching sessions, especially the non-judgmental approach of coaches
- greater student participation and engagement as a result of their teaching growth

While some tools TISS provided were underutilized by teachers, all teachers spoke of multiple program attributes that were improving their teaching practice. The two program features most commonly credited as attributing to their positive growth as science teachers were:

- the trainings they received on science notebooks
- the one-on-one support provided by coaches

Other effective program features commonly cited were:

- the approach of learning by doing
- the consistent collaboration in a space dedicated to reflection around science, something they rarely experience outside TISS



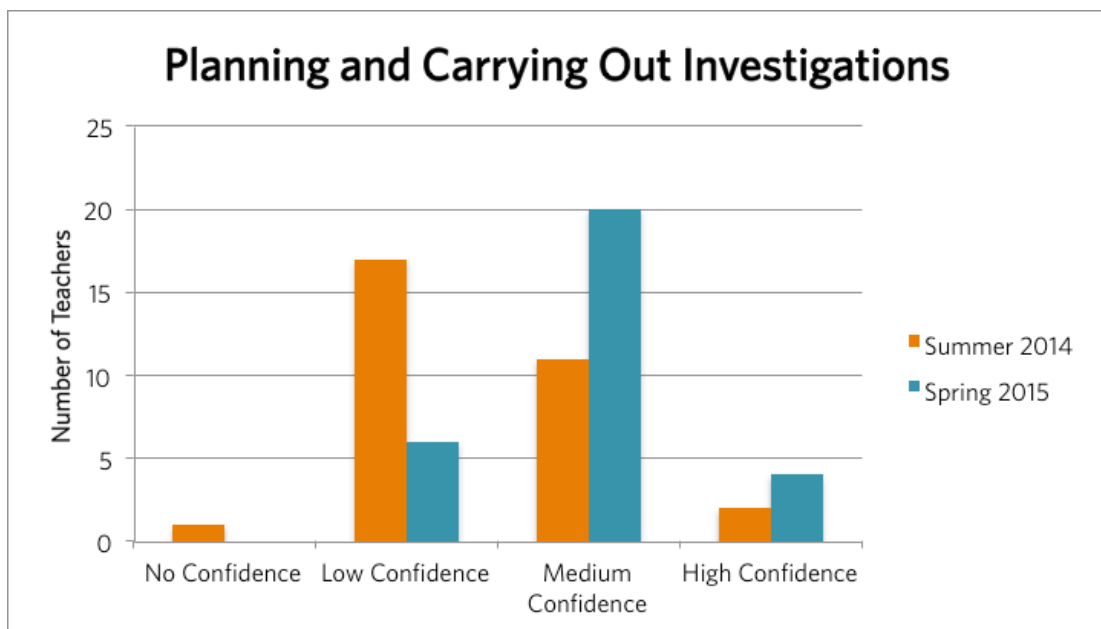
Cohort 6 Survey

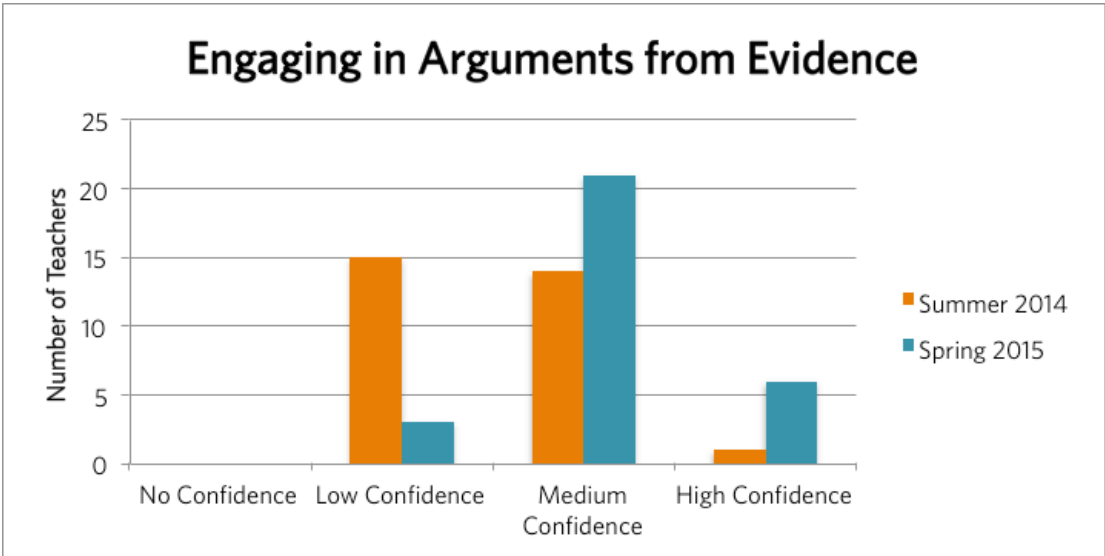
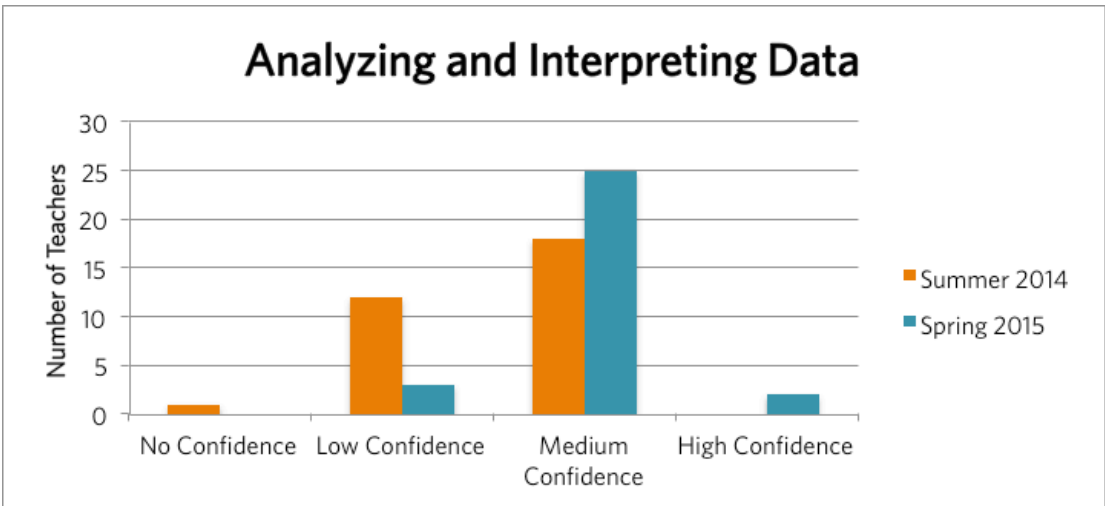
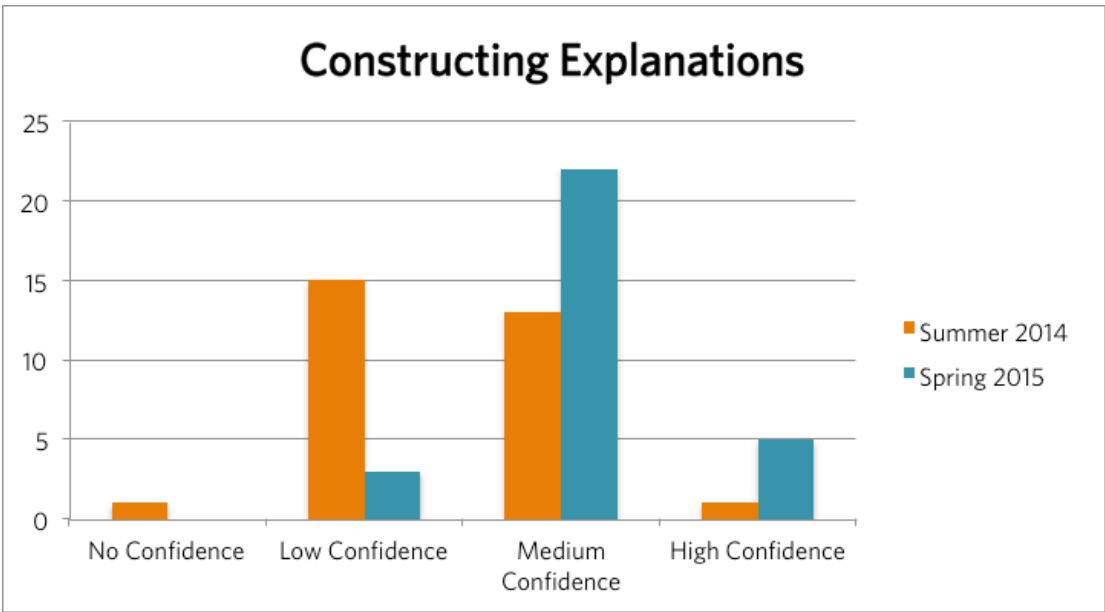
Over the course of the 2014-2015 school year, SRI measured teacher change through a before and after survey. It was first given to Cohort 6 TISS participants on their first day of programming in the summer of 2014 to provide a baseline for tracking change. The follow-up survey was administered during the final professional development (PD) workshop of the school year in April 2015.

Survey items were designed to elicit teacher insight into their own teaching practices and experiences in the classroom. Survey topics included relevant NGSS science practices, pedagogical strategies, science identity and confidence, collaboration with colleagues and experiences in the TISS program. Teachers reported positive growth in many areas over the course of their first year in the TISS program.

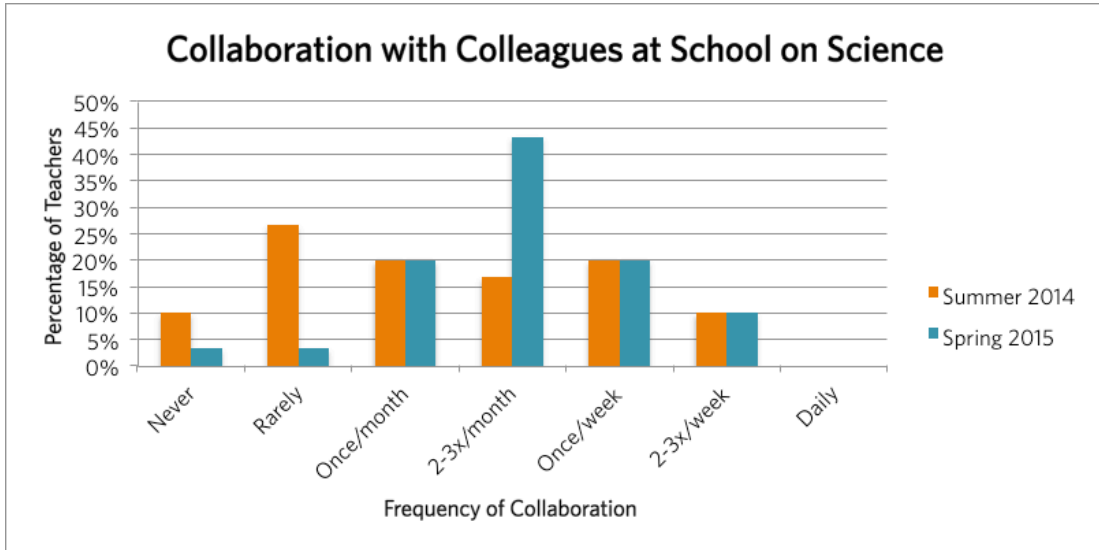
NGSS Practices: During 2015-2016, TISS focused on several NGSS science practices in PD workshops and supported teachers in implementing these practices in their classrooms through observations and coaching.

Survey data show that Cohort 6 teachers reported an increase in their confidence to enact the following NGSS practices in their classrooms: planning and carrying out investigations; having students analyze and interpret their own data; having students engage in argument from evidence; and having students construct their own explanations with a claim, evidence, and reasoning.

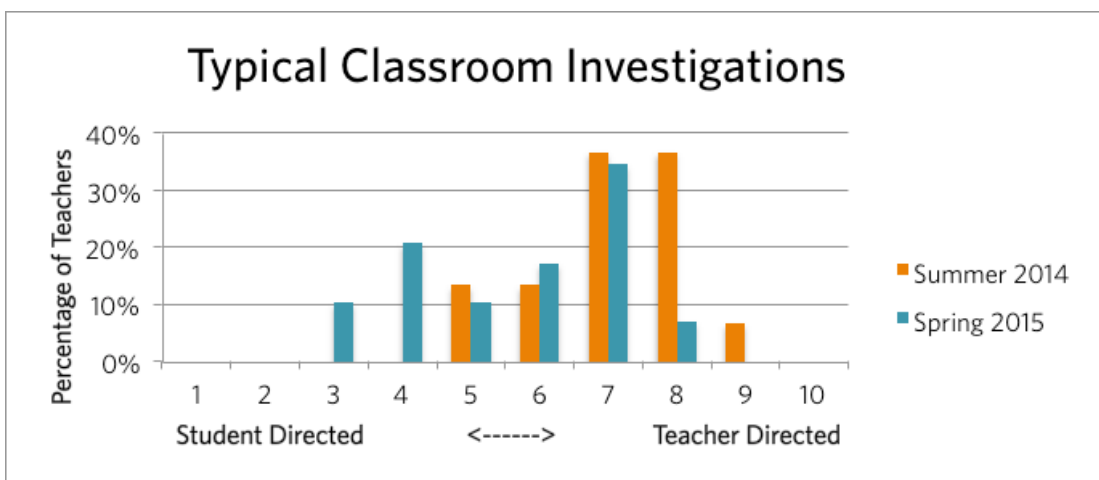




Collaboration: Across the cohort, teachers reported an increase in the frequency with which they collaborated with their colleagues at school on science. Prior to the TISS program, over half of Cohort 6 teachers reported infrequent collaboration, at most once per month. However, over the course of their first year in TISS, well over half of these same teachers reported collaborating on science at least 2 to 3 times per month.



Student-Centered Teaching: Lastly, SRI explored how student-directed teachers perceive their science teaching to be, a major emphasis of TISS training. Student-directed investigations were defined as those times when students have a great deal of autonomy to pose their own questions, design their own investigations, and discover and explain their own results. Teacher-directed investigations were those in which teachers pose questions for students, provide methods or procedures for students to follow, identify results, and provide explanations for the results. Data from the pre- to post-survey showed that a greater percentage of teachers were moving towards more student-directed investigations. While student-centered teaching is not objectively better teaching, it implies the degree to which students have agency and ownership over their science activities, which TISS holds as a pedagogical stance.



Key Findings of School Case Studies

In 2015 SRI researchers conducted retrospective case studies on two elementary schools that have each sent four cohorts of teachers to TISS, interviewing each TISS participant to better understand his or her individual growth as a science teacher and the collective change at the school.

Maxwell Elementary School

- Maxwell has sent several teachers to participate in each of four different TISS cohorts, starting in 2011.
- Initially, many TISS teachers collaborated with administration to create a school wide plan for science support and instruction.
- Three TISS teachers taught an NGSS workshop for the school, with support from TISS staff. This was the only NGSS training Maxwell teachers have received to date.
- Administrative shifts at the school, and an increased focus on other content areas, curtailed these systematic efforts. Independently teachers remain fervent in their science engagement.
- TISS teachers are currently spending more time on science than non-TISS teachers, typically 1.5-2 hours per week.
- Some collaboration with lesson planning still occurs at Maxwell among TISS teachers, but far less once teachers complete their two years of professional development.
- Enduring mainstays of the TISS program at Maxwell include the use of student notebooks in a TISS-specific way, modification of FOSS lessons to be more student-centered and hands-on, and the use of focus questions for science lessons and unit planning.
- When former TISS teachers moved to teaching lower grades, they continued to bring a science perspective to grade level meetings and encouraged other teachers to do more science.
- The current educational climate, including Common Core and high-stakes testing, has inhibited systematic TISS impact at a school wide level.
- TISS teachers have remained dedicated to implementing science that aligns with TISS pedagogy.

Posey Elementary School

- Overall, TISS teachers at Posey genuinely desire to implement student-centered science, giving students time to play and experiment with materials and to make sense of them on their own.
- Students ask more of their own questions and spend more time on discourse and group work.
- The initial principal (2010) encouraged science professional development and significant classroom time dedicated to science teaching. Principal turnover led to less science focus.
- There is significant variation in the amount of student-centered science, the chief prohibiter being



lack of time to teach science due to the school's recent focus on literacy.

- Teachers experienced markedly different TISS programming over five years. Early cohorts gained more sustainability knowledge; later cohorts gained more pedagogical tools for teaching within their current curriculum.
- Currently, no teachers dedicate a significant amount of time to teaching sustainability, reporting that there is no time for content outside the curriculum.
- The district has given focus-area designations to schools. Posey is dominated by its focus on literacy; other subjects have been de-prioritized.
- Most recent TISS participants continue to focus much energy planning and teaching student-centered science; less recent cohorts teach the FOSS curriculum with small alterations to meet student needs or increase student agency; Non-TISS teachers teach very little science.
- Collaboration around science teaching occurs mainly between teachers in the same cohort during their two years in the program; after, teachers mostly revert to isolation.
- Teachers cite three main causes for the lack of science collaboration: diminished teaching time for science due to school literacy focus, complete absence of school-wide science professional development, and the lack of a champion/facilitator to encourage science collaboration.
- All TISS teachers continue to use science notebooks with their students; most use a system that closely resembles the TISS model.
- Notebooks are the most visible and enduring impact of TISS and they encourage students to produce critical thinking, writing, and sketching using the scientific method.
- One TISS alumnus is currently serving as a district science coach and credits TISS with preparing her. A second alumnus is currently developing guides for the district that offer guidance to teachers on how to use FOSS to meet NGSS goals.



Maxwell Elementary Case Study

Background

Maxwell Elementary is located on a tree-lined street in one of San Francisco's most quickly gentrifying neighborhoods. As a part of San Francisco Unified School District, Maxwell's student body reflects much of the cultural diversity of the city while primarily serving lower-income students from Pre-K to fifth grade. Among its resources, Maxwell boasts an urban school garden as well as a dedicated science resource center. *(Please note - "Maxwell Elementary" is a pseudonym to protect the anonymity of the actual school studied.)*

Case Study Methodology

Maxwell began participating in the California Academy of Sciences' Teacher Institute on Science and Sustainability (TISS) during the professional development program's third year in 2011, with a small group of teachers in Cohort 3, and have sent teachers to TISS in each subsequent year through Cohort 6. During the 2015-2016 school year, as Cohort 6 was approaching graduation, the Academy engaged SRI International to conduct interviews with the teachers at Maxwell to better understand individual growth by TISS participants, in addition to collective change at the school.

Over time, some participating TISS teachers have moved grades; as such, this cohort now includes teachers covering grades kindergarten through five in addition to the science resource specialist who teaches almost all Maxwell students at least once a week. Additionally, the teachers range in experience from new teachers with two years of experience to those with up to two decades of experience in the classroom. To be able to serve teachers with such different experience levels in the classroom is a testament to the TISS model of professional development, which focuses on modeling effective teaching practices, then individualizing support for each educator.

While the TISS program has shown that it is flexible enough to support teachers on their individual development, a lingering question has remained: does TISS produce a systemic school-wide shift as more of its teachers participate in this professional development?

Aiming for Collective Change

The need for support from schools and districts to make a substantial impact on teaching cannot be underscored. Teachers and educators are universally emphatic that they increasingly have less and less time to devote to lesson planning, collaboration with their peers, and professional development. These are all key components of creating a cultural shift in a school, and are also key components of the TISS program. TISS accepts teachers into their program on a school cohort basis, with multiple teachers from each school



per year, and when lucky, multiple years of teachers from the same school. Their hope is to inseminate the school site with teachers trained in the TISS way of science, confident in science content knowledge and empowered with current teaching strategies, who have two years of communicating and collaborating together on science, and who will continue to collaborate with their peers on science. How does this actually happen, though? Is participation in this 2-year professional development enough to create lasting change at schools through the conduit of continually improving TISS alumni? Or, rather, are a school's ecosystem and the external forces that shape it too impermeable to allow these long-term impacts? This case study explores these questions in detail.

The Importance of Administrative Support

A former principal at Maxwell Elementary with a passion for science education spearheaded the school's shift to science-focused professional development (PD) when he/she encouraged the first teachers to apply to the two-year program with TISS. After the first two cohorts of Maxwell teachers shared their positive experiences from participating in this intensive program, the principal at the time asked for the remaining teachers in grades 3-5 to apply; as a result, the entire upper elementary team would be trained in the TISS method of science.

A Shift to Student-Led Investigation

This administrative support would prove to be instrumental to the promotion of science education at Maxwell. As teachers progressed through the two-year TISS program, their understanding and appreciation for science investigations grew. These teachers began doing more and more science investigations as they participated in TISS, as their understanding of how to modify lessons and open them to student inquiry increased through the coaching and workshops they received. Although the investigations take longer, teachers see the benefit of having youth have more hands-on investigations in science. As one Maxwell teacher explained, "They, the students, are discovering and learning by themselves. They are asking the questions."

Motivated Program Participants

Maxwell teachers had various motivations for applying to TISS, especially the first teachers from Maxwell to join the program. One of the teachers with over ten years of experience noted that she was interested in an intensive PD program that would allow her to "learn how to teach science better, and in different ways" than she had before. Another teacher noted that her interest in sustainability is what brought her to the TISS program as part of Cohort 3. "I thought those were the best PDs, when we learned about carbon. It was exciting, it felt like we discovered things on our own."



By the beginning of Cohort 4 in summer 2014, TISS moved away from focusing on sustainability education. Some teachers at Maxwell from earlier cohorts lamented the loss of the sustainability lens in TISS PD, sharing that they now turn to the school's garden educator and other local outdoor educators for lesson plan ideas. One teacher noted that while she has been able to find other resources on sustainability education, she had hoped that the TISS program would help her incorporate this content into her existing science curriculum.

This shift away from sustainability was strategic, however. As California adopted the Next Generation Science Standards (NGSS) in 2013, TISS saw an opportunity to offer Bay Area teachers a chance to begin learning how to apply the NGSS in their classrooms, in addition to focusing on student inquiry as an engaging teaching practice. In fact, the only training on NGSS that Maxwell teachers received that school year was from TISS staff; teachers reported that the workshops and coaching were invaluable to ground them in these new science standards.

Towards School-wide Impact

Pivoting towards teaching practice rather than focusing merely on content standards had a positive effect that reached beyond just participating teachers. In 2014, three TISS teachers at Maxwell worked together to lead a half-day, schoolwide training on NGSS. Incorporating knowledge and resources from the Academy, with some support from TISS coaches along with resources from their district, these teachers led an overview of the NGSS science standards and practices to share this valuable knowledge with their colleagues. A teacher in attendance who later joined Cohort 6 who attended this PD shared that she was "grateful that the people who first went to TISS looked at NGSS and drew more interest in it," as this was the first introduction many Maxwell teachers had to this content.

There was a groundswell of energy and support for science teaching at Maxwell during the 2014-2015 school year, as there were seven teachers involved with TISS. To capitalize on their own investment in science teaching and learning, these seven teachers aimed to disseminate the TISS philosophy and pedagogical strategies with the full Maxwell teaching staff, hoping to mobilize the teaching staff to spend more time on science during the school year. However, these teachers knew that increasing time dedicated to science would require buy-in from school administrators and the district. Fortunately, the principal at the time was a former science resource teacher, and was a critical stakeholder in pushing science as schoolwide priority.

In the fall of 2014, TISS teachers convened a meeting with two TISS coaches, the principal, and two district representatives. Together they created a plan to support Maxwell staff in collaborating on science. Specifically, it would involve professional development for teachers who wanted to learn more about science, the creation of a Fall Science Night to complement the annual science fair, and updating of the school's



shared stockpile of FOSS science materials. The district agreed to provide support and pay for substitutes so that teachers could conduct more grade-level planning around science.

Unfortunately, this plan was never enacted. For one, there were some staffing shifts at the district level. More critically, a new principal arrived at Maxwell shortly thereafter, and the support for science waned significantly. The focus on math and language arts, especially considering the high population of English Language Learners at the school, had taken priority at the school level, pushing back on time for science across the grades.

Maxwell Now

In spite of this disappointing setback, teachers at Maxwell have continued to independently apply what they have learned at TISS in their own classes. The use of student notebooks in a TISS-specific way, modification of FOSS lessons to be more student-centered and hands-on, and the use of focus questions for science lessons and unit planning have shown to be the enduring mainstays of the TISS pedagogy. Teacher collaboration in science lesson planning has also continued, albeit to a much lesser degree than during each teacher's two-year TISS stint.

Most of the teachers involved in TISS continue to teach science once or twice per week for 45 minutes each session. Additionally, all but one teacher sends their students to the TISS-trained science resource specialist once a week. On average, students in these classrooms receive between 1.5 to 2 hours of science per week, during weeks where there is no testing. This is more time spent on science than non-TISS teachers at the school, who primarily teach the lower grades. This is a point of contention at the school, as students in these lower grades often only had exposure to science during their weekly session with the science resource teacher. However, TISS teachers are finding ways to not only continue to focus time on science, but also individually encourage other teachers to do the same. One TISS teacher who is now teaching Kindergarten shared that although the other K teachers were not teaching science, she "was excited about TISS and would always try to bring in the science perspective in our grade level meetings."

This lack of abandonment of science in spite of systemic challenges, and the support teachers are providing to one another, demonstrates these teachers' continued engagement with the content. However, it's not just time spent on science that may signal TISS impact, but also the increased rigor in teaching methodology. Teachers reported doing more hands-on science investigations that have been very successful, as students "can manipulate the materials to answer the questions they're trying to answer." Many teachers are continuing to use focus or essential questions to guide their lesson planning and science instruction. The use of notebooks has also deepened and improved. One teacher notes, "I wasn't using them in such a clear and organized way before TISS. The structure they had, with codes for investigation, notes, vocabulary, they're



more organized now after TISS.”

While on average teachers were quite positive of TISS impact, it is not always as easy job to implement. One teacher notes that since she has been implementing a more TISS-style science instruction, students “are more engaged, but in terms of classroom management it is more difficult. You really have to have the classroom management down for this to be successful.”

Conclusion

In the current educational climate, schools in the Bay Area are getting pushed harder and harder to focus on math and language arts. This trend persists even with the continued adoption of NGSS. While TISS cannot entirely overcome school or district pressures on teachers, it can and has encouraged individual teachers in schools to both improve science teaching, increase (or maintain) time on science, and promote some level of leadership within schools around science. The TISS model of recruiting several teachers over several years from the same school increases the chance of more school-wide penetration of science, but this study did not find strong evidence of that penetration outside of current and past TISS participants.

Creating powerful, long-term change at schools across teaching staffs within the current education climate is no small task. In light of this case study and the case study on Posey Elementary, it is clear that having both early and ongoing buy-in from administration is an essential ingredient for positive change. Considering the fluidity of administrative personnel, the TISS program should consider grooming science champions within teacher cohorts and maintaining support for them following completion of the program. Alternatively, TISS could make administrative buy-in a requisite part of school eligibility, focusing more energy on developing relationships with school leaders to facilitate some degree of science advocacy (e.g., encouraging school leaders to allow and support TISS teachers in running science workshops). Other strategies could include follow-up visits from TISS coaches or follow-up correspondence via email. As time is drained from science to boost ELA and math minutes, some science professional development groups have placed more emphasis on teaching subject integration strategies. In other words, by showing teachers how to connect subjects like ELA and science, those educators can better maintain science instruction in the midst of pressure to boost ELA minutes. Whatever direction TISS takes in its efforts to catalyze long-term staff-wide change within schools, it is quite apparent that additional resources, energy, and creativity will be requisite and TISS has a strong record of adaptability to meet shifting goals.



Posey Elementary Case Study

Background

In 2010, Posey Elementary School in Oakland began sending teachers to participate in the California Academy of Sciences' [Teacher Institute on Science and Sustainability](#) (TISS) professional development program. Since then, four pairs of teachers have completed the two-year program, each in separate cohorts. Due to shifting personnel and pedagogy, each cohort experienced different programming and, in turn, left with varying lessons, emphases, and teaching styles. This case study aims to parse out the impacts TISS has had on Posey, both its teacher participants and the school as a whole, within the evolving context of the Posey learning environment. *(Please note - "Posey Elementary" is a pseudonym to protect the anonymity of the actual school studied.)*

Posey's Golden Age of Science Teaching

In 2009, the Teacher Institute on Science and Sustainability was established, welcoming in its first cohort of approximately 30 educators, made up solely of San Francisco teachers. The following year, an enthusiastic teacher at Posey convinced her grade level colleague to apply with her to make the requisite teacher team; the two of them eventually became TISS's first Oakland participants. Posey's involvement was no fluke, though. The school's principal at the time was dedicated to advancing science learning at Posey Elementary, as evidenced by the school's annual field trips to Camp Royal in Livermore, a place where students could learn about sustainability. Fittingly, the original TISS coaching staff was also fully dedicated to preparing educators to teach about sustainable science. In their first year with TISS, the two Posey teachers spent their time learning about ways to build green buildings. At one of the workshops dedicated to this theme, Academy staff invited an architect who specialized in sustainable building to present to teachers.

Fueled by their newfound knowledge and supportive coaches, Posey's initial cohort spent their first year in the program working to build lessons for their students based on the TISS workshops. They continued to teach [FOSS curriculum](#) just the same, but added green building projects to their science courses. The following year, the focus of the Teacher Institute's professional development switched to sustainable eating, prompting these two Posey teachers to teach their students about the importance of eating locally. They took their students on field trips to farmers markets, began gardening in pots, ate what they grew, and produced brochures on how to eat sustainably. After graduating from TISS, the Posey teachers maintained their momentum, building planters in the schoolyard with the financial support of the school district, and encouraging other teachers to use this school garden as well. One TISS teacher's students conducted studies on what was viable to grow in California's climate, made charts to explain nutritional value of planted crops, measured light, developed watering and weeding schedules, and harvested food that year.



These two teachers were deeply impacted by these years of science professional development, by both the TISS program and the energy of the school surrounding science learning. They reported that the greatest shifts in their teaching occurred around:

- integrating sustainability content into their science curriculum,
- introducing science notebooks to facilitate more critical thinking and writing, and
- a shift from lecture-style teaching to more student autonomy and exploration.

Currently, one of these teachers is serving as a science coach for Oakland Unified School District. She reports using many lessons she learned from her TISS coach, especially the strategies of asking questions to induce reflection and providing her teachers with just as much positive as critical feedback. As of spring 2015, the second of those two teachers continues to teach at the same grade level and is currently helping prepare other teachers for the Next Generation Science Standards (NGSS). She commented, "If it wasn't for TISS, I wouldn't have had the confidence to apply" to serve on Oakland's Science Instructional Reflection and Assessment team, on which she creates documents that offer advice on how to augment FOSS to support NGSS teaching.

A Less Science-focused Posey

Following the initial cohort of Posey teachers who participated in TISS from 2009-2011, the subsequent three years each welcomed a new pair of Posey teachers. For these teachers, the Teacher Institute was a very different experience, as the program transitioned away from its strong focus on sustainability and toward preparing its teachers to take on NGSS, specifically the NGSS Science Practices.

Posey's second and third cohorts (TISS's third and fourth, overall) did experience some sustainability exposure; for example, one TISS teacher recalls learning a lot about carbon footprints, sustainable food packaging, and producing commercials to promote sustainability. While reporting on how much they enjoyed these activities, these TISS graduates left the program with much less motivation to transplant the content of their TISS workshops into their classrooms, compared to previous cohorts. Instead, they worked to internalize the science teaching practices that TISS modeled during workshops and attempted to employ them spontaneously when opportunities arose during their lessons. For one teacher, he explained that he doesn't alter his prescribed FOSS lesson plans significantly, but he is "more natural and spontaneous about putting science practices into lessons." He believes that his students ask more questions now and argue from evidence more often, but he still feels that he should do a better job allowing students to work independently or design parts of their investigations.



At Posey, these years also saw the transition away from a science-focused school leader. Soon, the school's subject focus became "balance literacy" to align within Oakland's initiative to have school specializations. By 2015, as one teacher put it, "A lot of teachers don't really teach much science." The TISS teachers, while pressured to spend most of their energy on literacy, are still teaching science two to three times per week, which they suspect is much more than their colleagues.

When discussing the impacts TISS had on the ways they teach science, the middle cohorts report minor impacts. For one teacher, science notebooks have been the largest change; he uses them to encourage more writing, thinking, and sketching. For the other teacher in that cohort, his biggest shift is the introduction of a larger purpose to each lesson, what he calls the "so what" portion of the lesson, which gives it meaning outside of a singular activity. But in general, these Posey educators teach the FOSS curriculum with little adaptation to the activities themselves, without adjusting the amount of student agency they allow.

While feeling that they have seen what strong science instruction looks like, these six teachers expressed how they are not implementing it as well as they could. They want to create larger, more meaningful science projects, like the ones they completed during TISS workshops. They want to spend more time adapting their FOSS lessons to allow for students to take on more agency in designing experiments. But because the atmosphere of the school has changed, they lack both the planning and teaching time to take on student-centered science, along with the peer support and coaching that make the process collaborative. In fact, science professional development meetings have stopped occurring at Posey. Most of the training is on balanced literacy, and with that has come the expectation that teachers focus their energy on literacy as well. For these middle cohorts, there is a suppressed energy around science; they know the requisite steps that would make their science instruction stronger, but they feel severe limitations in the current environment.

Motivated Program Participants

Despite Posey's declining science focus, its current TISS cohort has been poised to improve their science teaching throughout their two years in the program. They continue to try new methods, adapt and enhance their FOSS curriculum, collaborate with each other, and pursue insights from earlier TISS graduates.

This latest cohort entered the TISS program in 2013 and experienced a coherent professional development program organized around five science teaching practices: asking questions, constructing explanations, arguing from evidence, planning and carrying out investigations, and analyzing data. Over the course of their two years of the program, these two teachers participated in workshops on each of those practices, after which coaches observed their teaching and facilitated reflective sessions with a clear, deliberate focus on those practices.



This latest team of teachers is proud of the progress they have made. Before teaching a science lesson, they consider which science practices best align with the activities and intentionally build out those aspects of the lesson to ensure that students are improving those essential science skills. One teacher also reported thinking through how much she can remove herself from the lesson to allow students to take over the critical thinking aspects of the investigation. Her partner teacher takes a similar approach, allowing her students to explore and guide investigations much more than before.

These motivated teachers report observable impacts on their students as a result of the shift in their science teaching. Their students appear more curious, trust their own judgment and intuition rather than depending on the teacher, and come away from science activities with a deeper understanding of the phenomena they were studying, rather than valuing the memorization of minor facts.

Main Findings

- 1. Overall, TISS teachers at Posey genuinely desire to implement student-centered science learning.** Nearly every TISS teacher commented that they make sure to allow students time to play and experiment with materials, to make sense of them on their own in a more stress-free structure. They report that their students ask more of their own questions and spend more time on science discourse and groupwork. However, there is significant variation in the degree to which these teachers implement student-centered science, the chief limitation being a lack of time due to the school's recent focus on literacy.
- 2. Teachers experienced markedly different TISS programming over the course of five years.** Early cohorts gained more content knowledge (mostly around sustainability) that they attempted to bring directly back to their classrooms. Later cohorts gained more pedagogical tools for teaching within their current curriculum. As of now, there are no teachers who dedicate a significant amount of time to teaching sustainability as it is perceived as too unaligned with their curriculum, given their time constraints for teaching science.
- 3. School-wide culture or district priorities affect the freedom of TISS teachers to apply their learning.** As part of the Oakland Unified School District, Posey is dominated by its focus on "balanced literacy," creating an environment in which all other subjects have been deprioritized. The most recent TISS participants continue to focus a significant amount of energy planning and teaching student-centered science. Less recent cohorts teach the FOSS curriculum in a mostly scripted fashion with some alterations to meet student needs or increase student agency. Non-TISS teachers at the school teach very little science.



4. **Collaboration around science teaching occurs mainly between teachers in the same cohort during their two years of TISS participation.** Following those years, teachers revert to teaching science in a mostly-isolated fashion. Teachers cited three main causes for this lack of collaboration: diminished teaching time for science due to “balanced literacy,” a complete absence of school-wide science professional development, and the lack of a facilitator/champion to encourage teachers to collaborate around science.

5. **All TISS teachers, current and former, continue to use science notebooks with their students, typically using a method of organization that closely resembles the TISS model.** Notebooks are the most visible and enduring impact of the TISS program and they continue to serve the function of encouraging students to produce critical thinking, writing, and sketching within the structure of the scientific method.

Conclusion

Over the past five years, Posey Elementary has consistently evolved. As a case study, it offers valuable insights into a modern urban school facing very typical pressures from district and federal policies, in addition to changing leadership with shifting priorities.

In analyzing the experiences of TISS teachers at Posey, it is readily apparent that TISS has instilled (or at least maintained) a deep motivation for improving science teaching practice, especially during each teacher’s two-year program stint. Upon graduating, alumni feel that they are not given the time and space to be able to actively improve their science instruction, but they do consistently teach science, unlike their non-TISS colleagues.

In order to encourage continual reflection, collaboration, and improvement, it seems that some continued interaction between TISS and its graduates could be useful. For example, this could take the form of a refresher on ways to encourage high-level science notebook use or merely a space to check in with peers about challenges and innovations within their science instruction. As the past seven years have shown, TISS is capable of generating creative solutions to meet rising needs. Building systems to facilitate more long-term growth and school-wide penetration could be a useful expenditure of TISS thought and energy.



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