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Michael R. L. Odell
University of Texas at Tyler, modell@uttyler.edu

Teresa J. Kennedy
University of Texas at Tyler, tkennedy@uttyler.edu

Eric Stocks
University of Texas at Tyler, estocks@uttyler.edu

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SPECIAL ISSUE: UNPACKING THE ROLE OF ASSESSMENT IN PROBLEM- AND PROJECT-BASED LEARNING

The Impact of PBL as a STEM School Reform Model

Michael R. L. Odell, Teresa J. Kennedy, and Eric Stocks (University of Texas at Tyler)

ABSTRACT

Project/problem-based learning (PBL) can provide an effective model for school reform when implemented with fidelity. In the report, *Rising Above the Gathering Storm,* it was recommended that if the U.S. is to remain competitive in the 21st-century economy, there must be a serious effort to "enlarge the pipeline of students who are prepared to enter college and graduate with a degree in STEM" (National Academy of Sciences, National Academy of Engineering, & Institute of Medicine, 2007, p. 6). The report included the recommendation that states develop statewide specialty STEM high schools (National Academy of Sciences, National Academy of Engineering, & Institute of Medicine, 2007, p. 6). In 2010, the Texas Science, Technology, Engineering, and Mathematics Academy (T-STEM) initiative was implemented to develop specialty STEM schools similar to those described in *Rising Above the Gathering Storm*. The primary instructional strategy of T-STEM academies is problem- and project-based learning. In the STEM context, PBL is well suited as a primary pedagogy for STEM learning. This paper examines the following questions: What outcomes occur when PBL is implemented in a low performing school district? What is the role of PBL in school improvement? What are the challenges to implementing PBL with high fidelity?

Keywords: problem-based learning, project-based learning, fidelity, STEM, project-based instruction, evaluation, PBL

Introduction

Creating and implementing new school models to meet the needs of students and society is a challenging task. In the current era of school accountability, the stakes can be high when implementing new models if things go awry. In the state of Texas, new charter school models must be "innovative" and utilize "innovative teaching methods" (Texas Education Code, 2009). Although the term innovative is not defined in the statute, new charter schools are not intended to recreate traditional schools. The primary advantage of developing a charter school is that the designation provides relief from many state regulations. That said, charter schools are held to the same accountability standards as all public schools in Texas. It can be argued that struggling charter schools are held to a higher standard, because charter schools in Texas that do not meet the accountability standards for three out of five years are subject to closure by the state (Texas Education Code, 2013).

This project examined a charter school district in Texas that did not meet the accountability standards on its initial launch and the role that formative evaluation played in turning the school district around. Formative evaluation is the process of examining a program with the goal of determining what is working, what is not working, and why it is, or is not working. Formative evaluation determines the efficacy of programs and serves as a guide for improvement (Rossett & Sheldon, 2001). In this case, formative evaluation was a useful process to assist the district in examining its own processes and practices. Data were used to guide fiscal, personnel, and academic decisions. This included using existing fiscal and academic data sources maintained by the district and state accountability data, as well as collecting additional data to understand what went wrong.

Another goal of the evaluation was to embed ongoing evaluation strategies throughout the district and its programs. The U.S. Department of Education provides a guide for evaluation of education programs, *Evaluation Matters*, which includes an embedded evaluation model for school programs (U.S. Department of Education, 2014). Figure 1 illustrates an embedded evaluation design as presented in *Evaluation Matters*.

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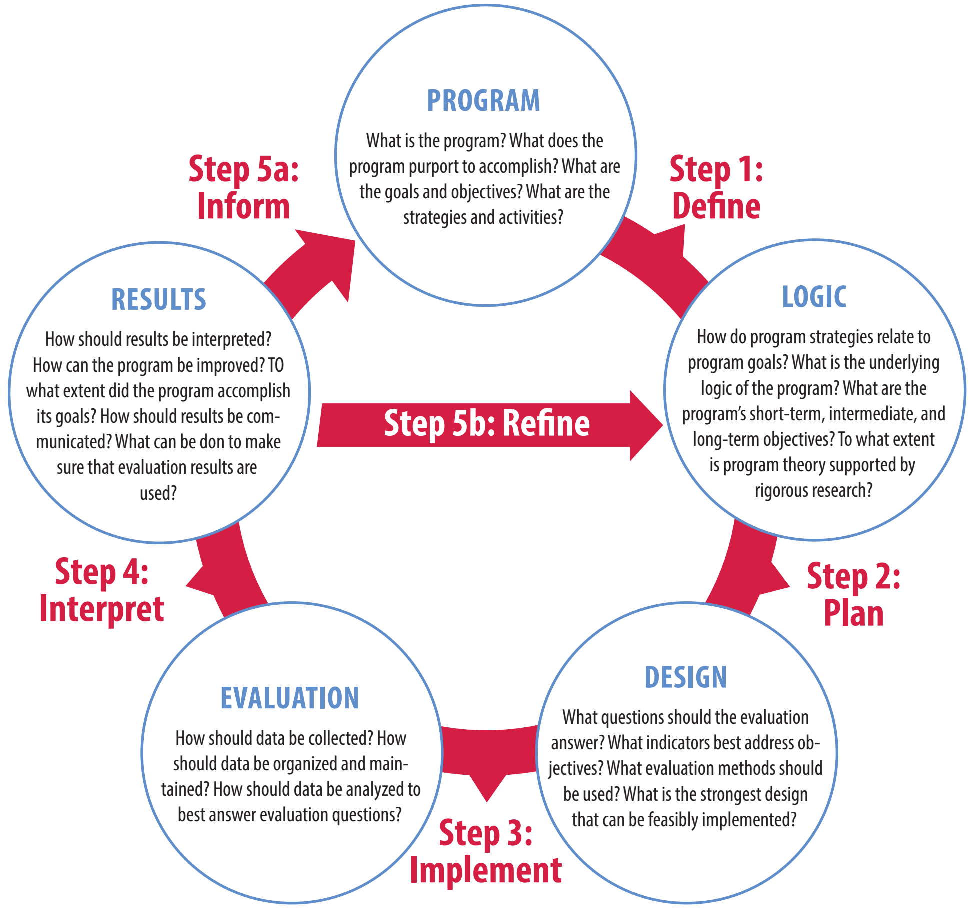

Figure 1. Embedded evaluation model by U.S. Department of Education (2014).

The Charter School Model Rationale

In the report, *Rising Above the Gathering Storm,* it was recommended that if the United States is to remain competitive in the 21st-century economy, there must be a serious effort to "enlarge the pipeline of students who are prepared to enter college and graduate with a degree in [science, technology, engineering, and mathematics] STEM" (National Academy of Sciences, National Academy of Engineering, & Institute of Medicine, 2007, p. 6). This could be accomplished by increasing the number of students who complete and pass advanced STEM courses. The report recommends states develop specialty STEM high schools:

> Specialty secondary education can foster leaders in science, technology, and mathematics. Specialty schools immerse students in high-quality science, technology, and mathematics education; serve as a mechanism to test teaching materials; provide a training ground for K–12 teachers; and provide the resources and staff for summer programs that introduce students to science and mathematics. (National Academy of Sciences, National Academy of Engineering, & Institute of Medicine, 2007, p. 6)

Given the shortage of students in STEM disciplines, the developers of the charter district submitted a charter application to create a district comprised of specialty STEM schools. Rather than create a new model, the charter operators adopted the Texas STEM (T-STEM) academy model. T-STEM academies follow a blueprint to create high quality secondary schools that prepare students for postsecondary STEM majors and careers in STEM fields. The T-STEM Academy Blueprint provides specific guidelines that academies must follow (Avery et al., 2010; Educate Texas, 2015). There are two primary T-STEM academy models: standalone T-STEM academies and school-within-a-school T-STEM academies. For schools to be "STEM designated" by the Texas Education Agency as a T-STEM academy, districts and schools are required to address the following seven benchmarks:

1. mission driven leadership;
2. school culture and design;
3. student outreach, recruitment, and retention;
4. teacher selection, development, and retention;
5. curriculum, instruction, and assessment;
6. strategic alliances; and
7. academy advancement and sustainability.

There have not been many studies on effectiveness of T-STEM academies in Texas. One factor has been the large number of school-within-a-school model implementations. Achievement data for schools using the school-within-a-school model are not disaggregated and are part of the overall school accountability results. As a result, it is not possible to use publically available data to determine the impact of academies implementing this model. However, achievement data in 2011 indicated T-STEM academies outperform peer schools in meeting college-readiness benchmarks. T-STEM academies scored at a 12% higher rate and achieved a 21% higher completion rate in dual credit and advanced placement courses (Texas Education Agency, 2018). As of 2018, there were 132 T-STEM academies operating in the state of Texas.

Background

In 2011, the Texas Education Agency chartered a new school district that sought to implement the T-STEM academy model. One of the innovations of the new district was to expand the T-STEM model beyond the high school level and include all grade levels K-12. The district opened three stand-alone T-STEM academies. These new academies would modify the T-STEM High School Academy Blueprint to implement it at all levels for the K-12 continuum. Rather than start at the high school level, the district developed a model that would phase in grades over time to build a foundation of students and teachers (see Table 1).

Table 1. District phased growth additional grades by school year.

Grades	Year
3-6	2012-2013
3-7	2013-2014
3-8	2014-2015
2-9	2015-2016
1-10	2016-2017
K-11	2017-2018
K-12	2018-2019

In the district's submitted charter application, implementing the T-STEM Academy Blueprint was specifically referenced as the chosen model for the district's educational design. The district modified the blueprint to create two additional versions to account for elementary and middle grades. The original high school blueprint would remain the primary guiding document.

Benchmark 5 (curriculum, instruction, and assessment) was particularly important concerning the instructional pedagogy to be implemented throughout the district. Benchmark 5 specifically references Project/Problem-Based Learning (PBL) as the preferred primary instructional strategy for T-STEM academies. PBL was considered an appropriate instructional strategy for a STEM focused school. STEM, by its nature, is inquiry-driven, and PBL is an inquiry-based strategy. Inquiry-based pedagogical approaches are recommended in STEM education policy documents and in the research literature (Bransford, Brown, Cocking, & U.S. National Research Council, 1999; Bybee & Fuchs, 2006; National Research Council, 2000; National Research Council, 2012; National Science Teachers Association, 2011).

PBL as an instructional strategy is not always taught as part of educator preparation programs in Texas. Therefore, teacher preparation issues were anticipated, and as a result, an intensive professional development program was created to prepare teachers. In the summer preceding the opening of the district academies, the district provided all teachers with six weeks of training. Designing projects and implementing PBL was the focus of four weeks of the training. During the school year that followed, teachers were provided an additional planning period during the day to allow more time for planning of PBL lessons.

In late spring 2013, state accountability tests were administered district wide. In August of 2013, the state released the results of the accountability tests that revealed the district did not meet the state accountability standard. In fact, the district scored in the bottom 5% when compared with all districts in the state.

The district administration believed they had followed the T-STEM Academy Blueprint. The district had provided intensive PBL training, planning time and follow-up professional development. PBL as a primary instructional strategy had been implemented across the district. What went wrong?

Concerned about the performance of the school, the school board authorized an internal evaluation report. The evaluation team consisted of university researchers and district personnel. The goal of the evaluation was to identify what went wrong and make recommendations for corrective action. Some board members blamed the PBL approach. The district charter obligated the school to provide instruction through PBL. Was PBL to blame for the failure on the state accountability assessments?

Evaluation Approach

In Texas, charter schools are required to implement the educational plan as submitted to the state of Texas in the charter application. Following the embedded evaluation model presented earlier, the evaluation team set to work by first examining the approved charter application and the T-STEM blueprints. Since this was not a traditional program evaluation, there was no initial logic model to reference. In lieu of a logic model, the evaluation team focused on the T-STEM Blueprint Rubric (Avery, Chambliss, Pruiett, & Stotts, 2010) that is an appendix to the blueprint document. The T-STEM Rubric served as a de facto logic model.

The T-STEM Rubric

"The T-STEM Academies Design Blueprint Rubric is intended to serve as a road map for benchmarks, program requirements, and indicators to facilitate individual STEM academy growth along the continuum of developing, implementing, mature, and role model" (Educate Texas, 2015, p. 10.). T-STEM academies use the rubric to complete an assessment of fidelity to the T-STEM Academies Design Blueprint prior to and following each academic year as part of annual school improvement planning. In coordination with district personnel, the research team utilized the rubric as the guiding evaluation instrument to develop recommendations for identifying areas of strength and for addressing areas for growth in the District's Annual Action Plan.

An examination of the charter application confirmed that the T-STEM Academy Blueprint was the primary guiding document referenced. The charter also outlined the strategies for meeting the blueprint benchmarks. After a thorough examination of the approved charter application and the blueprint, the evaluation team concluded that the best approach to identifying what went wrong required a detailed examination of each of the benchmark metrics as outlined

Benchmark 5: Curriculum, Instruction, and Assessment. *Program Requirement: 5.1 Rigor.*

Example Artifacts

- Course syllabi, lesson plans, unit lessons, PBL, scope, sequence, pacing guides
- Lessons include STEM standards, state standards, national standards, college and career readiness standards, 21st century skills
- Benchmark schedule, course passing rates, retention rates
- Student portfolios, IGPs, counseling, advising, college crosswalk, and feedback loop
- Plans for PSAT, Accuplacer, TSI, CTE, interventions, etc.
- Horizontal and vertical alignment of curriculum
- Students graduate with Endorsements & Performance Acknowledgements

In Benchmark 5, all program requirements are scored individually. There are no separate metrics. Assess the level of implementation for the program requirements below according to the standards to the right	**Developing** Investigate, Research, and Create	**Implementing** formalize, Revise, and Publish	**Mature** Data-driven evaluation of effectiveness of program requirements	**Role Model** Continually assesses to document successes and challenges with action plans implemented to correct deficiencies in performance
5.1A Aligns curriculum, instruction, and assessment (such as, but not limited, the THECB CCRS, national and state standards, content, context, culture, cognitive level, competencies, skills, processes, 21st century skills, and STEM synthesis).	☐	☐	☐	☐
5.1.B Develops a scope, sequence, and pacing guide for a vertically and horizontally aligned curriculum centered on state standards, career and college readiness standards, STEM integration and industry expectations.	☐	☐	☐	☐
5.1.C Develops an assessment and intervention plan to address gaps in student achievement and areas for extension	☐	☐	☐	☐
5.1.D Supports and encourages all students to successfully complete four years of mathematics, four years of science, four years of STEM electives, and at least one Endorsement in STEM, Business and Industry, Public Services, or Arts and Humanities, with a primary focus on a STEM Endorsement; and earn a Distinguished Level of Achievement as well as a Performance Acknowledgement in order to graduate college ready.	☐	☐	☐	☐
5.1.E Offers dual credit, articulated concurrent enrollment, AP or IB courses so that all students will graduate with 12-30 college credit hours	☐	☐	☐	☐
5.1.E Establishes curriculum expectations, monitoring, and accountability mechanisms that are reflectively revised to ensure a constancy of mission purpose (aligned resource allocation, integrated STEM curriculum development, teacher professional growth, and student results).	☐	☐	☐	☐

Figure 2. Sample T-STEM rubric and indicators (Educate Texas, 2015).

in the blueprint rubric. The T-STEM Rubric suggested evidence and artifacts to support ratings on the rubric. Sources of evidence included existing data sources, financial records, attendance data, classroom artifacts, project lesson plans, teacher observations, administrative walk through forms, among other items with an eye on fidelity to the blueprint and to PBL as an instructional strategy. The T-STEM Rubric provides example artifacts that, when examined, determine how a STEM academy is progressing. Figure 2 is an example for Benchmark 5.1: curriculum, instruction, and assessment.

The evaluation team and school district personnel began evaluating the school in comparison to the benchmarks and metrics outlined in the rubric. The timeline for the evaluation was very short. Evaluators were required to complete the preliminary evaluation within four weeks in order to disseminate the report to all stakeholders by October 1, 2013.

Student Population Served

An examination of district demographics indicated that the academies had lower proportions of economically disadvantaged students and English Language Learners (ELLs) than surrounding public schools and the state as a whole. Based upon comparisons of test scores of school districts with similar demographics, the district was underachieving. No other district with similar demographics was failing to meet the standard on state accountability measures.

Table 2. District demographics across three different schools as a percentage.

Demographic	Percentage *(N=548)*
African American	3.5
Hispanic	14.4
White	75.2
Other	6.6
Economically disadvantaged	21.2
English language learners	3.3
Special education	5.8
Bilingual	3.1

Blueprint Examination

The Blueprint Rubric was broken down based on the seven benchmarks and assigned to committees led by a university researcher. During the month of September, each committee met, examined artifacts, scored the rubric, and made recommendations to the district superintendent and board. In addition, researchers interviewed teachers and administrators for their insights. Evaluators also observed classrooms to examine PBL in action.

Table 3 provides a summary of the findings of the evaluation of the individual benchmarks. The columns at the right of the table indicate progress on a benchmark. Ratings for each benchmark include:

- Role Model (R): There is evidence that the academy is a role model for other academies.
- Mature (M): There is evidence that the academy has institutionalized.
- Implementing (I): There is evidence that the academy is implementing.
- Developing (D): There is evidence that the academy is planning for implementation.
- No Evidence (N): There is no evidence that the academy is implementing.

The committees did not utilize the Mature (M) and Role Model (R) ratings in the rubric, as the academies had just completed one year of operation. There was no expectation that a newly approved district would be implementing the blueprint at the advanced levels. The final column contains an X if the committee concluded that benchmark metric should be a priority. Although the focus of the study was the district, each of the academy's data are included in the district evaluation. The academies are identified as follows: Academy 1 (A-1), Academy 2 (A-2), and Academy 3 (A-3).

Analyses

An examination of Table 3 revealed common areas of need across the district and within academies. The most pressing areas of concern included indicators from Benchmarks 4 and 5:

- Teacher quality: 100% of schools scored developing on this outcome.
- Teacher support: 100% of schools were not implementing this element of the blueprint.
- Use of data to inform practice and planning: 100% of schools were not implementing this element of the blueprint.

The evaluation team concluded that Benchmarks 4 and 5 had not been met with fidelity. A deeper examination of these two benchmarks was initiated. Benchmark 4 focuses on teacher selection, development, and retention. Under Benchmark 4, three critical indicators were not met. These included:

- Benchmark 4.1: Highly Qualified Teachers.
- Benchmark 4.2: Teacher Support and Development.
- Benchmark 4.3: Teacher Retention.

Table 3. benchmark findings by district and academy.

(D) Developing (I) Implementing (M) Mature (N) No Evidence (R) Role Model	**District**	**A1**	**A2**	**A3**	**Focus**
Benchmark 1: Mission-Driven Leadership					
1.1.A Shared Mission and Vision	D	D	D	D	
1.1.B Annual Action Plan	D	D	D	D	
1.2.A-G Leadership and Governance	D	D	D	D	
1.3.A-B Data Informs Program Review and Evaluation	N	N	N	N	X
1.4.A-C 6th–12th Leadership Collaboration w/ T-STEM Centers & Coaches	I	I	I	I	
Benchmark 2: STEM Academy Culture and Design					
2.1.A-C Personalization: Remains small, Advisory program, Student Voice	D	I	I	I	
2.1.D-F Personalization: Flexible day, Student exhibits, STEM IGP	I	I	I	I	
2.2 Professional Learning Community (PLC) and Positive School Culture	I	I	I	I	
2.3 Postsecondary Success Support (College and Career), 12-30 credit hours	N/A				
Benchmark 3: Student Outreach, Recruitment, and Retention					
3.1 -3.2 Recruitment and Open Access	I	I	I	I	
3.3 Student Support and Retention, Summer Bridge, STEM extracurricular	I	I	I	I	
Benchmark 4: Teacher Selection, Development, and Retention					
4.1 Highly Qualified Teachers	D	D	D	D	X
4.2 Teacher Support and Development: PD plan, PLC, STEM instruction	N	N	N	N	X
4.3 Teacher Retention: Orientation/Mentoring, Common planning, Incentives	N	N	N	N	X
Benchmark 5: Curriculum, Instruction, and Assessment					
5.1 Rigor: Aligned Curriculum & Assessment, Endorsement, 12-30 college hrs.	N	N	N	N	X
5.2 STEM-focused Curriculum: STEM electives, PBL, STEM Extracurricular, Portfolios, Internship/Capstone	N	N	N	N	X
5.3 Instructional Practices: Data-driven, PBL, Student choice/voice	N	N	N	N	X
5.4 STEM Education Integration: Innovate, Invent, STEM literacy, Technology	D	D	D	D	
5.5 Literacy: 21st Century Skills, Read, Write, Speak, Present, STEM Vocabulary	D	D	D	D	
5.6 Assessment: Standards, Diagnostic, Summative, Performance-based, Tracks	DN	N	N	N	X
Benchmark 6: Strategic Alliances					
6.1 Parent and/or Family Participation: Communication and Connection plan	D	I	I	I	
6.2-6.3 Business and School Community; Institutions of Higher Education **6.4** Communication with Alliance Members and Stakeholders, Track Graduates	D	D	D	D	
Benchmark 7: Advancement and Sustainability					
7.1 -7.2 Strategic Planning; Continuous Improvement and Evaluation	N	N	N	N	X
7.3 -7.4 Sustainability and Growth; and Program Advancement	D	D	D	D	

Benchmark 4.1 B, "collaborative recruiting process for selecting highly qualified teachers" was evaluated (Educate Texas, 2015, p. 3). In other words, how teachers were hired, supported, and retained. The district had created a hiring committee that included administrators and practitioners. On the surface, it appeared that the benchmark indicator was met. However, upon closer examination, evaluators found that state certification was the primary factor in hiring. The hiring process did not take into account the teacher's instructional background. Evaluators recommended changing the hiring process by requiring teacher applicants to submit videos of teaching and integrating technology into teaching. This would allow the hiring committee to view the instructional toolkit future teachers would bring to the district.

Benchmark 4.2 B focused on a professional development model for teacher continuous learning. The evaluation team reviewed agendas and held discussions with teachers and administrators to determine the content and opportunities for professional learning. It was concluded that professional learning was not focused and, furthermore, that teachers had great flexibility in participation. As a result, evaluators recommended that professional learning time be mandatory and focused, that school data be used to identify district teacher needs, and that professional learning plans be developed for school-wide needs as well as individual teacher needs.

Benchmark 4.3 required teachers to be provided with a common planning time within the structure of the school day. The district had indeed provided a common planning time in addition to the state mandated conference period. This additional time was supposed to be an opportunity for teachers to meet and collaborate on project development and to plan for student interventions to address student needs. Although teachers and administrators had received extensive training in PBL, an examination of artifacts (including teacher plans, observations of teachers teaching, and student products) indicated that teachers were struggling to develop high quality PBL lessons with adequate rigor. It was also found that teacher-developed problems and projects did not adequately align with state assessments. An examination of planning time also indicated that teachers were often using that time for other activities. The administrators had assumed that simply providing additional time would result in well-developed lessons. In addition, teachers did not utilize student data to plan their instruction. Teachers were provided a data tool to assist in analyzing student data, however, they were provided minimal training and ongoing support in the use of data tools. Because evaluators found the common planning time was not being used as designed, it was recommended that the common planning time be planned and coordinated to ensure teacher collaboration by grade level and discipline. The goal was to make sure that teachers utilize data to design projects, embed activities that support higher performance on state accountability assessments, and work together to improve school culture. Both horizontal and vertical alignment meetings were incorporated into the model. In addition, it was recommended that the district invest in instructional coaches to support teachers in professional learning and support PBL implementation.

Four indicators in Benchmark 5 were not met based on the rubric analysis. These included:

- Benchmark 5.1: Rigor: Aligned Curriculum and Assessment.
- Benchmark 5.2: STEM Focused Curriculum.
- Benchmark 5.3: Instructional Practices (Data-driven, PBL, Student Voice).
- Benchmark 5.6: Assessment Practices.

Benchmarks 5.1 and 5.2 required the district to develop rigorous "integrated STEM curriculum, assessment, and instruction for each academy" (Educate Texas, 2015, p. 8). The district had not provided teachers with a scope and sequence for each grade level. Instead, the district wanted teachers to develop the curriculum and projects as the school year proceeded. Typically, teachers do not have the background or experience to develop high quality curriculum without the support of curriculum specialists. Discussions with teachers indicated high levels of frustration from trying to create curriculum at the appropriate level in a PBL environment that was new to teachers. Even though teachers had been provided extensive summer training, teachers indicated that additional support was needed throughout the year. The evaluation team's recommendation reiterated the need for instructional coaches to support teachers.

Benchmark indicator 5.3 required teachers to implement project-based and problem-based curriculum, instruction, and assessment. Teachers were struggling to develop and implement high quality PBL in the classroom. The evaluation team made additional recommendations to support teachers and make certain that PBL was implemented in the classroom with rigor and fidelity. A common assessment practice in schools is the administrator walk through. An examination of administrator walk through observation forms and teacher observation forms found a major disconnect between expected PBL instruction and what the observation form documented. Administration was using an observation form designed for traditional instruction. To achieve fidelity, the evaluation team recommended that district and school administration adopt a new walk through protocol and forms for documentation that addressed PBL. To ensure PBL implementation in each classroom, it was recommended the district require all classrooms to organize and decorate their rooms to foster PBL. Teachers were presented with the idea that if a PBL classroom was set up properly, an administrator should be able to visit an empty classroom and know that PBL was taking place simply by the artifacts displayed in the classroom. A common decoration format for a PBL wall was implemented in all classrooms at all grade levels. The wall was a dedicated space that included entry documents, know and need to knows, project calendars, check points, question parking lot, and student artifacts. These elements were added to the administrator walk-through procedure to verify the consistency of PBL in every class.

Benchmark 5.6 required implementing assessment protocols to inform instruction. This included developing PBL lessons that integrated a variety of assessment strategies to better inform instruction and prepare students for state exams. The district designated a member of the leadership team to work with teachers to embed formative assessments in all PBL lessons that were being delivered. In addition, a database of assessment items was created to document alignment with the new district scope and sequence and the state assessments. These items were also used to augment summative assessments created by teachers.

Effects of Implementing Evaluator Recommendations

The evaluators worked with district and campus level personnel to create district and individual school improvement plans. The improvement plans included the creation of a professional development plan to re-train and support all teachers in PBL. Teachers had already received significant training in PBL after they were initially hired; however, the follow-up support providing post-training had not been adequate. In the revised professional development plan, all teachers were required to complete two weeks of common PBL training annually. Newly hired teachers received an extra 2-week training period. Additionally, as a recruitment strategy, new teachers (when possible) were graduates of educator preparation programs that included PBL approaches.

To provide post-training support, the district invested in PBL coaches that would work alongside teachers throughout the school year. These instructional coaches were identified from within the district by the administration from the pool of existing teachers who had demonstrated they implemented PBL instruction in their classrooms with high levels of fidelity and whose students performed well on state assessments.

The district restructured the common planning time for all teachers. The common planning time was structured and facilitated by the coaches where teachers planned projects designed to improve school culture, student achievement, PBL instruction, and the development of 21st-century skills. To facilitate data-driven practices, the district invested additional resources into the use of data as a tool to improve outcomes. An administrator was reassigned to become the data manager for the district and assist teachers and administrators in using data to improve performance. Each semester included a data summit to help teachers focus on student data to plan interventions.

Over the next three years, these changes led to positive results. Table 4 shows the growth in state assessment scores before and after evaluation and implementation of the previously described recommendations. In 2013, the district ranked in the bottom 5% of school districts in the state. By 2018, the district ranked in the top 12% of school districts as measured by accountability tests. The evaluation team maintains a presence in the district to assist in monitoring success and to help identify challenges and solutions.

Table 4. State assessment before and after intervention.

	2013	**2014**	**2015**	**2016**	**2017**
	Pre-Intervention		*Post-Intervention*		
Math					
State	75	75	81	75	79
District	44	56	75	80	85
Science					
State	79	78	78	80	79
District	54	67	78	88	85
Reading					
State	76	76	76	75	72
District	72	7	83	85	86
Writing					
State	70	71	83	85	86
District	52	54	78	76	78

Table 4 illustrates the impact of the intervention over the past five years. District test scores have shown continuous improvement. In contrast, during this same timeframe, the state average on assessments has remained constant or declined. Even though the academies are focused on STEM, all subject area assessments improved, and the district continues to outperform the state average on all assessments. In addition to better student achievement, there were other indicators of improvement. These included better student engagement, as measured by a decrease in the number of discipline referrals, and an increase in the attendance rate from 95% to 97%.

Discussion

Throughout the evaluation process, there were a number of challenges identified when implementing PBL. Implementing PBL requires teachers to reexamine their role in the classroom. Teachers must become coaches that facilitate knowledge. This shift from a teacher-centered classroom environment to a student-centered learning environment can be difficult for many teachers. Most teachers, when initially hired, are not prepared in PBL approaches, nor have they experienced PBL as a student in a classroom.

Fidelity was another area that merits additional investigation. In this evaluation project, it was clear that there was a lack of fidelity to the school model as outlined in the blueprint. There was also a lack of fidelity in the implementation of the PBL instructional model caused by a misalignment of district supports and the intended outcomes. When district support structures, such as walk-through forms, are not aligned with the PBL instructional model, it sent mixed messages to teachers. Once these structural and procedural issues were resolved, teachers were able to focus on implementation with fidelity.

There were two findings that merit additional investigation. One unanticipated outcome of implementing PBL in the district was the number of teachers that self-selected out of the district annually when they found the PBL approach to be too time intensive or in conflict with their personal teaching philosophy. Many teachers had experience using traditional pedagogies for fifteen years or more. Teachers indicated this made it harder to learn and implement an entirely new method of teaching.

These preliminary data suggest that new teachers adapt better to implementing PBL in the classroom. “New teacher” in this sense is not an indication of age, but rather refers to time since completion of an educator preparation program. In other words, teachers with less experience appeared to adapt better to PBL. This resulted in newly prepared teachers more often being retained by the district the following year. This was counter to the conventional wisdom that teachers with more classroom experience would have an easier time implementing new instructional strategies. There may be an optimum time in the career of a teacher to transition from traditional pedagogies to PBL. This is an area for further investigation.

References

Avery, S., Chambliss, D., Pruiett, R., & Stotts, J. L. (2010). *T-STEM academy design blueprint, rubric, and glossary.* Retrieved from http://www.edtx.org/uploads/general/pdf-downloads/misc-PDFs/2011_TSTEMDesignBlueprint.pdf.

Bransford, J., Brown, A. L., Cocking, R. R., & U.S. National Research Council. (1999). *How people learn: Brain, mind, experience, and school.* Washington, DC: National Academies Press.

Bybee, R. W., & Fuchs, B. (2006). Preparing the 21st century workforce: A new reform in science and technology education. *Journal of Research in Science Teaching, 43*(4), 349–352. Retrieved from http://onlinelibrary.wiley.com/doi/10.1002/tea.20147/epdf

Educate Texas. (2015). *T-STEM academy design blueprint*. Retrieved from http://www.ndisd.net/hs/2015-blueprint.pdf.

National Academy of Sciences, National Academy of Engineering, & Institute of Medicine. (2007). *Rising above the gathering storm: Energizing and employing America for a brighter economic future.* Washington, DC: The National Academic Press. Retrieved from https://www.nap.edu/catalog/11463/rising-above-the-gathering-storm-energizing-and-employing-america-for.

National Research Council. (2000). *Inquiry and the National science education standards.* Washington, DC: National Academies Press.

National Research Council. (2012). *A framework for K–12 science education: Practices, crosscutting concepts, and core ideas*. Washington, DC: National Academies Press.

National Science Teachers Association. (2011). *Quality science education and 21st century skills*. Retrieved from http://www.nsta.org/about/positions/21stcentury.aspx.

Rossett, A, & Sheldon, K. (2001). *Beyond the podium: Delivering training and performance to a digital world*. San Francisco, CA: Jossey-Bass/Pfeiffer.

Texas Education Agency. (2018). *Texas science, technology, engineering, and mathematics initiative (T-STEM)*. Retrieved from https://tea.texas.gov/T-STEM/.

Texas Education Code 12.152 (c-12), (2009).

Texas Education Code Section 12.115 (c-1), (2013).

U.S. Department of Education, Office of Elementary and Secondary Education, & School Support and Rural Programs. (2014). *Evaluation matters: Getting the information you need from your evaluation*, Washington, DC.

Michael R. L. Odell, PhD, is a professor of STEM education and holds the endowed Roosth Chair in Education at the University of Texas at Tyler. Odell holds a joint appointment in the College of Education and Psychology and the College of Engineering. He cofounded the University Academy charter schools, which also serve as Laboratory Schools for the School of Education. He also established the Ingenuity Center, one of seven designated STEM Centers in Texas. In addition to his faculty appointment, Odell has held a number of administrative positions at UT Tyler, including the director of the School of Education and the vice president for Sponsored Research.

Teresa J. Kennedy, PhD, holds a joint appointment as professor of international STEM and bilingual/ELL education in the College of Education and Psychology and in the College of Engineering at the University of Texas at Tyler. She served as president of the International Council of Associations for Science Education (ICASE) from 2014–2017 and currently serves on the Executive Committee of ICASE as the representative to UNESCO. Kennedy is a two-time Fulbright Scholar, first in 1993 in Ecuador, and again during the 2014–2015 academic year focusing on engineering education in Argentina. Her research interests include STEM education, international comparative studies, gender equity, and brain research in relation to second language acquisition and bilingualism.

Eric Stocks, PhD, is a professor of social psychology at the University of Texas at Tyler. He holds a PhD in social psychology from the University of Kansas. Stocks' research interests include motivation and emotion, research design and statistics in project evaluation, and person perception.