The promise and challenge of school-wide Lesson Study in the United States

Catherine C. Lewis
cclewis150@gmail.com
https://orcid.org/0000-0002-0557-0876
Mills College at Northeastern University
Oakland, CA
Justin Stodard
stoddardj@sfusd.edu
https://orcid.org/0009-0001-1492-5974
John Muir Elementary School (SFUSD)
San Francisco, CA
Joshua D. Lerner
lerner.joshua@gmail.com
https://orcid.org/0009-0006-4319-461X
Helen C. Peirce School of International Studies, Chicago Public Schools (CPS)
Chicago, IL
Hanna A. Sufrin
hannasufrin@gmail.com
https://orcid.org/0009-0005-3148-4241
Oakland Unified School District (OUSD)
Oakland, CA

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Abstract

This paper describes school-wide Lesson Study, a type of site-based professional learning that is near-universal in Japan but rare in the United States. After discussing the core elements of school-wide Lesson Study, we examine its promise and challenges in the United States. Promise is shown in the demonstrated potential of school-wide Lesson Study, when joined with an approach such as Teaching Through Problem-solving, to solve two persistent problems of U.S. education: (1) transforming mathematics learning to center on problem-solving; and (2) addressing the opportunity gap faced by students from historically marginalized groups. We identify two principles underlying successful development of school-wide Lesson Study: support for teachers' intrinsic motivation; and teacher-administrator joint leadership. Together, these principles are posited to support teachers' collective efficacy, a powerful influence on student learning. Finally, we discuss a major challenge to school-wide Lesson Study: sustaining it across changes in school and district leadership.

Keywords: Lesson Study. Jugyou Kenkyuu. Mathematics Teaching. Professional Learning. Professional Community. Equity. Collaborative Lesson Research.

La promesa y el desafío del Lesson Study en toda la escuela en los Estados Unidos

Resumen

Este artículo describe el Lesson Study basado en la escuela, un tipo de aprendizaje profesional local que es casi universal en Japón pero raro en los Estados Unidos. Después de discutir los elementos centrales de Lesson Study en toda la escuela, examinamos sus promesas y desafíos en los Estados Unidos. La promesa se muestra en el potencial presentado por el Lesson Study en toda la escuela, cuando se combina con un enfoque como la enseñanza a través de la resolución de problemas, para resolver dos problemas persistentes en la educación de los EE. UU.: (1) transformar el aprendizaje de las matemáticas para centrarse en la resolución de problemas; y (2) abordar la brecha de oportunidades que enfrentan los estudiantes de grupos históricamente marginados. Identificamos dos principios subyacentes al desarrollo exitoso del Lesson Study en toda la escuela: apoyo a la motivación intrínseca de los docentes; y liderazgo conjunto maestro-administrador. Juntos, estos principios se postulan para apoyar la efectividad colectiva de los maestros, una poderosa influencia en el aprendizaje de los estudiantes. Finalmente, discutimos un gran desafío para el Lesson Study en toda la escuela: sostenerlo en medio de cambios en el liderazgo de la escuela y del distrito.

Palabras clave: Lesson Study. Jugyou Kenkyuu. Enseñanza de las matemáticas. Aprendizaje profesional. Comunidad profesional. Equidad. Investigación colaborativa en el aula.

A promessa e o desafio do Lesson Study em âmbito escolar nos Estados Unidos

Resumo

Este artigo descreve o Lesson Study em âmbito escolar, um tipo de aprendizado profissional local que é quase universal no Japão, mas raro nos Estados Unidos. Depois de discutir os elementos centrais do Lesson Study em toda a escola, examinamos suas promessas e desafios nos Estados Unidos. A promessa é demonstrada no potencial apresentado pelo Lesson Study em toda a escola, quando combinado com uma abordagem como o Ensino por meio da Resolução de Problemas, para resolver dois problemas persistentes da educação nos EUA: (1) transformar o aprendizado de matemática para centrar-se na resolução de problemas; e (2) lidar com a lacuna de oportunidades enfrentada por alunos de grupos historicamente marginalizados. Identificamos dois princípios subjacentes ao desenvolvimento bem-sucedido do Lesson Study em toda a escola: apoio à motivação intrínseca dos professores; e liderança conjunta professor-gestor. Juntos, esses princípios são postulados para apoiar a eficácia coletiva dos professores, uma poderosa influência na aprendizagem dos alunos. Por fim, discutimos um grande desafio para o Lesson Study em toda a escola: sustentá-lo em meio a mudanças na liderança da escola e do distrito.

Palavras-chave: Lesson Study. Jugyou Kenkyuu. Ensino de matemática. Aprendizagem profissional. Comunidade profissional. Equidade. Pesquisa de aula colaborativa.

Introduction

School-wide Lesson Study is near-universal in elementary schools in Japan (NIER, 2011), but rare in the United States. This chapter describes school-wide Lesson Study, which has three core elements: a long-term vision for student development shared by all educators at a school; Lesson Study cycles through which educators enact and study their vision in practice; and pathways that support knowledge flow within the school and with the outside.

We present three cases of U.S. school-wide Lesson Study; information on these cases (School S, School O, and School CE) is provided in a subsequent section of the chapter. The cases suggest the potential of school-wide Lesson Study to solve two daunting problems in U.S. education: (1) transforming mathematics instruction from "telling" by teachers to active knowledge creation by students; and (2) the opportunity gap faced by students from historically marginalized groups. From these cases, we identify two principles underlying successful school-wide expansion of Lesson Study–support for teachers' intrinsic motivation; and teacher-administrator joint leadership. We speculate that these two principles build teachers' collective efficacy, a powerful influence on student learning. Finally, we look at the challenges faced by schools as they try to build and sustain school-wide Lesson Study.

What is School-Wide Lesson Study?

School-wide Lesson Study has three core elements:

- A long-term vision for student development shared by teachers;
- Lesson Study cycles through which teachers enact and study their vision in practice; and
- Pathways that support knowledge flow within the school and with the outside.

Each of the three elements has an important function. The vision creates a sense of collective purpose among teachers and grounds the work in teachers' heartfelt goals. The Lesson Study cycles enable teachers to build and examine their vision in practice. The knowledge flow pathways enable teachers to learn from other teams within their school and from outside resources.

Shared vision

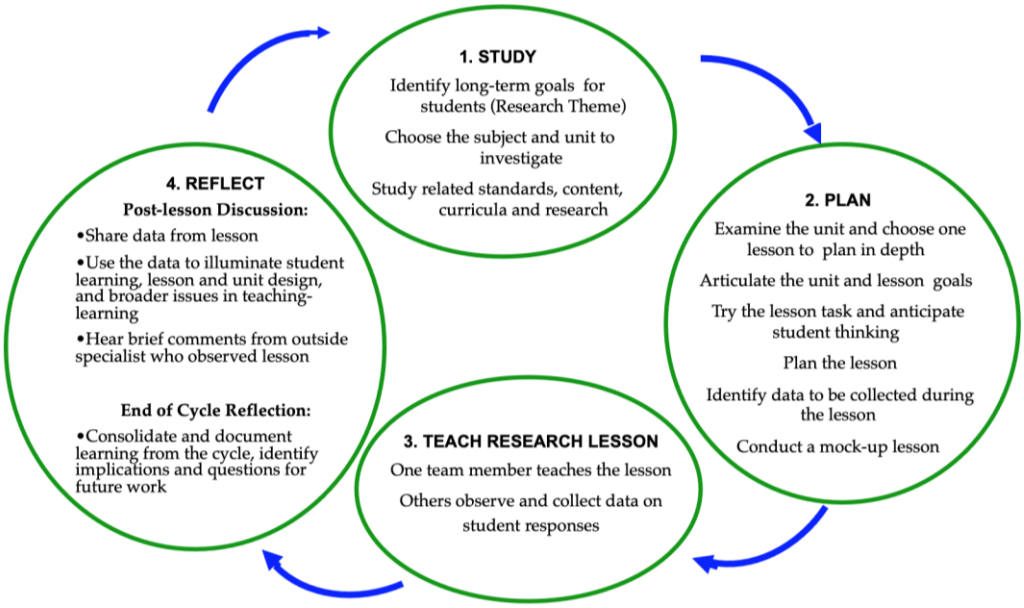
Teachers together identify the qualities they want all students to have at graduation or later in life and develop a vision statement that expresses these qualities. Schools often call this

vision statement a "Research Theme," (from the Japanese term *Kenkyuu Shudai*) or "Vision for Student Success." As part of the vision statement, teachers build a "Theory of Action" about how to achieve their vision–for example, that students' mathematical agency and identity is built through lessons that engage students in problem-solving and productive talk. A basic process for building the vision and theory of action is found in LSGAMC, 2022a.

Lesson Study cycles

Teachers conduct Lesson Study cycles (see Figure 1) that address a specific topic taught at the grade level and also the long-term vision for students. Typically, each Lesson Study team is made up of 3-6 teachers from a grade level or grade band. The team studies what is known about the teaching-learning of the topic and co-plans a "research lesson" designed to bring to life their ideas about teaching of the topic and about their long-term vision for students. Ideally, all teachers in the school observe the research lessons and discuss the implications for their shared school vision. In practice, it may take several years to lay the groundwork for many or all teachers at the school to observe all teams' research lessons.

Figure 1 - Lesson Study Cycle



Source: Elaboration by authors

Each phase of the Lesson Study cycle offers opportunities for teachers' learning. For example, the Study Phase allows teachers to look at a mathematical topic in depth, studying

curriculum, standards and research. After conducting a Lesson Study cycle on multiplication of fractions, teachers at School CE "just kept going on and on about how much they learned about the topic…they had taught this topic before but had never really understood it conceptually. It was really clear to them how much they had learned about the content." The next phase of the cycle, Plan, sparked further insights about the curriculum: As teachers anticipated the knowledge students needed for the research lesson, they realized that an idea in the curriculum that they "had glossed over earlier was actually important for the children's understanding of this topic."

Teaching a research lesson in front of colleagues for the first time is an experience that many teachers look back on as a pivotal moment in their career, when they realize the power of learning from colleagues and from practice. Justin Stoddard explains, "When you have a dedicated team of critical observers, it provides a unique opportunity to gather data on how different students are engaging in their work, misconceptions, and the patterns emerging with that particular group of students." Years later, teachers recall specific ideas from the post-lesson reflection phase, such as the simple question from an outside commentator: "What is the new learning in this lesson? Mathematics is joyful when students can expect to learn something new in every lesson." Josh Lerner reflects on the power of the post-lesson discussion:

> I think most people teaching a research lesson for the first time are somewhat intimidated or worried. But usually the result is that they listen really deeply to what is said because it's about them and their students, and they find it very inspiring in some way. For example, last spring, teachers extended the introduction of the lesson a lot more than we had planned, perhaps out of nerves, and front-loaded a lot of information to help students be successful once they were attempting the problem. Dr. Takahashi's final comments called this "just in case" teaching–telling students everything upfront just in case they need it, even though the goal is to challenge students to try to do it themselves. He contrasted this with "just in time" teaching, in which you plan out things to say or do only if needed.

Knowledge flow pathways

Knowledge flow pathways allow teachers to learn from one another and also from outside resources. Table 1 provides some examples of knowledge flow pathways at school-wide Lesson Study sites. These pathways differ from site to site, but share the same underlying purpose: ensuring that teachers can learn from each other and from outside knowledge resources.

Table 1 - Knowledge flow pathways

Pathway	**Examples**
Shared school-wide study of an outside resource	A book on educating for equity read by the whole faculty argues that joy and agency should be central to student learning; these ideas inform the vision of student success developed by teachers Teachers review videos of Teaching Through Problem-solving lessons (LSGAMC 2022b) to build their vision about how mathematics instruction nurtures self-confident, independent learners.
Bi-weekly school-wide inquiry prompt	Teachers collect and discuss individual classroom artifacts in response to a school-wide prompt such as "What do you do to support academic conversations in your classroom?"
Lesson Study teams study outside resources	Teams study standards, curriculum units and research; the team summarizes the implications of these resources in the research lesson Teaching-Learning Plan handed out to all observers
Lesson Study teams consult with outside specialists	Teams ask for feedback on the draft lesson plan from an experienced mathematics educator who poses questions or makes suggestions (e.g., "I understand the task but I am not sure what is the mathematics you want students to learn from this lesson") Teams invite an experienced mathematics educator to observe the research lesson and provide "final commentary" to help the team consider next steps in their learning (e.g., "You need to adjust the planned boardwork so that struggling students see their thinking represented on the board")
Teachers observe research lessons by other teams	Teachers closely observe students throughout a research lesson, seeing the instructional strategies used by colleagues to enact the school vision in practice; teachers see content, instruction and learning at other grade levels, so they can connect student learning over time to their own teaching
Lesson study newsletter or bulletin board shares team findings	Pictures and key learnings from different teams' research lessons are published in a newsletter or posted on a bulletin board so teachers can learn from the work of other teams
Teachers present or publish	Teachers present their Lesson Study findings to a state conference of mathematics educators, publish an article in a magazine for mathematics teachers, or conduct a research lesson as part of a professional conference, reshaping outside knowledge resources

Source: Elaboration by authors

School-Wide Lesson Study cases

Selection of the School-wide cases

The school-wide cases were chosen from 12 schools that worked with researchers[1] to build school-wide Lesson Study. Initially the project assumed that schools would use their locally-adopted instructional materials to improve instruction. However, during the 2015-16 school-year (the first year of the project), it became clear that local mathematics instructional resources did not offer sufficient support for teachers' Lesson Study work, so the researchers shared resources on Teaching Through Problem-solving in mathematics, creating or translating materials based on Japanese practice (LSGAMC, 2022c).

For this paper, we draw examples from three school-wide Lesson Study sites. In each of the three districts, we report on one school that focused on mathematics Lesson Study school-wide and that: (1) showed continued evidence of school-wide Lesson Study (many or all teachers participating) two years after the end of external funding; (2) showed evidence of positive changes in teaching and learning after starting school-wide Lesson Study; and (3) had an educator interested in co-authoring this chapter.

School demographics

Schools O and S are elementary schools in two large, urban West Coast districts. School CE is a PK-8 school in a large, urban midwestern district. As Table 1 shows, Schools S and O serve higher proportions of students from most historically underserved groups than do their respective districts. School CE serves a population of students similar to the district, with slightly lower proportions from some historically underserved groups.

[1] Catherine Lewis of Mills College and Akihiko Takahashi of DePaul University were co-principal investigators of the work; Shelley Friedkin co-led the Mills College team, working with Kathy Emerson, Kevin Lai and Laura Henn. District educators co-led the work in each district.

Table 2 - School and District Demographics

	Black	Latinx	Asian	White	English Learner	Low SES
School S	24.9%	51.6%	4.0%	2.7%	41.8%	84.0%
District S	7%	27%	35%	15%	28.1%	51.4%
School O	6.3%	89.5%	1.0%	2.1%	70.6%	92.0%
District O	23.9%	46.2%	11.8%	9.9%	31.2%	73.0%
School CE	10.8%	44%	6.3%	33%	18.7%	55.6%
District C	36.6%	46.6	4.1%	10.5%	19.4%	77.9%

Source: Elaboration by authors

Standardized tests

Districts O and S measure mathematics performance using SBAC (Smarter Balanced Assessment; California Department of Education, 2023), the standardized test used in about a dozen U.S. states. District C uses NWEA MAP. These two mathematics standardized tests differ considerably. SBAC is the product of a major assessment re-design to capture the ambitious instruction expected by the Common Core State Standards (NGACBP & CCSSO, 2010). Hence SBAC includes constructed-response items as well as multiple-choice items and it addresses four domains: concepts and procedures; problem-solving; communicating reasoning; and modeling/data analysis. It is administered once a year (starting in grade 3) and takes about 3.5 hours. Its grade-specific forms are aligned with the Common Core State Standards for the corresponding grade level.

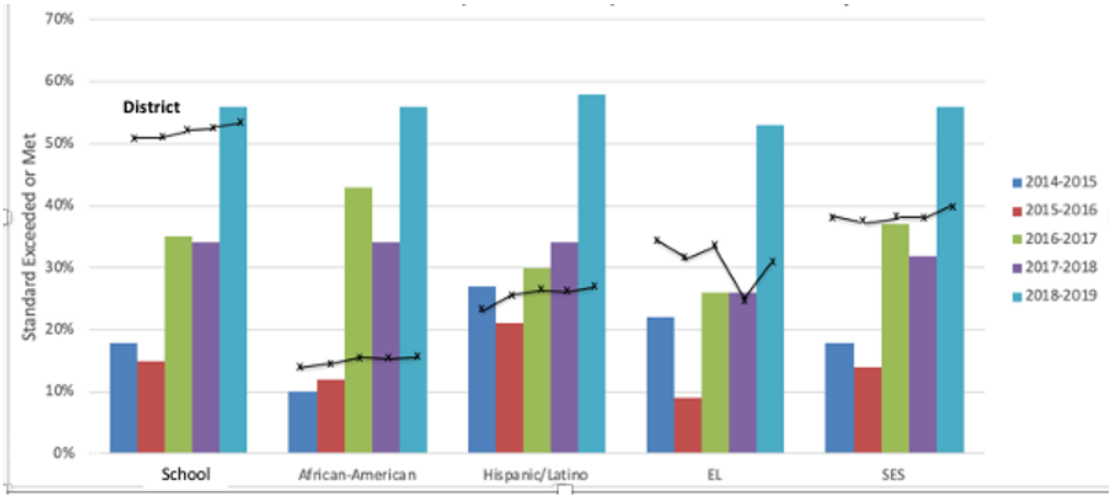
In contrast, the NWEA MAP used by District C is a fully multiple-choice assessment of 30-45 minutes, designed for repeated administrations three times during a school-year to provide brief feedback on students' mastery of specific mathematical content so that teachers can re-

teach topics as needed. NWEA's adaptive structure (a single computerized item bank for grades 3-5, with item selection determined by student response to the prior questions) means that students who answer grade-level items correctly are presented with above-grade-level content. It seems likely that NWEA's use of multiple grade-level items rewards superficial knowledge of not-yet-taught content and that the multiple-choice format fails to measure problem-solving or reasoning in depth. As a further challenge, NWEA's adaptive format substitutes a new item when students pause for a certain length of time during testing, a feature that may have been exploited by some District C schools to raise scores, according to a district report that questions the test's validity as a way to compare schools (Burke & Kunichoff, 2020).

Figures 2-4 show mathematics standardized test data from the three schools, starting the year before school-wide Lesson Study (2014-15) and going through the 2018-19 school year (four years into building school-wide Lesson Study and after external funding ended in 2018). Standardized tests were not conducted in 2019-20, due to COVID-19. In Figures 2-3, the bars show SBAC mathematics results for a school over time (for all students and demographic subgroups) and the x'd lines show district results. The difference between school and district results is striking. Schools S and O show dramatic increases in mathematics scores over time for the school and all demographic subgroups, whereas district-wide profiles show mostly flat growth profiles. In fact, School S's growth makes it a 3-sigma positive outlier in achievement growth within its district.

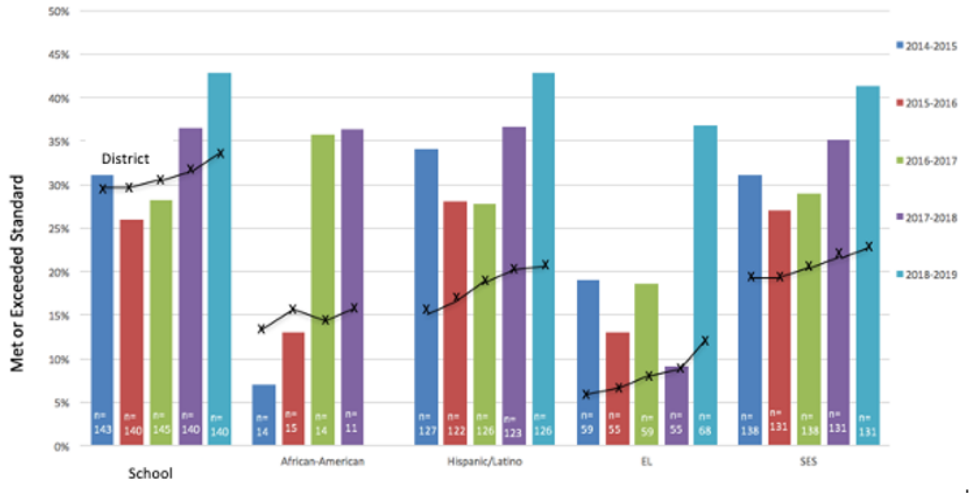
Figure 4 shows the NWEA MAP scores at all four school-wide Lesson Study sites in District C compared to the District. As it shows, the great year-to-year variability in test scores makes it hard to draw any conclusions about growth. However, outside educators (from across the United States and around the world) who attended District C's large public research lessons positively evaluated instructional quality and several lesson videos (with accompanying plans) are available online (LSGAMC, 2022b), so readers can judge instructional quality for themselves.

Figure 2 - SBAC Mathematics Proficient or Above, 2014-19, School S (bars) vs. District (lines)



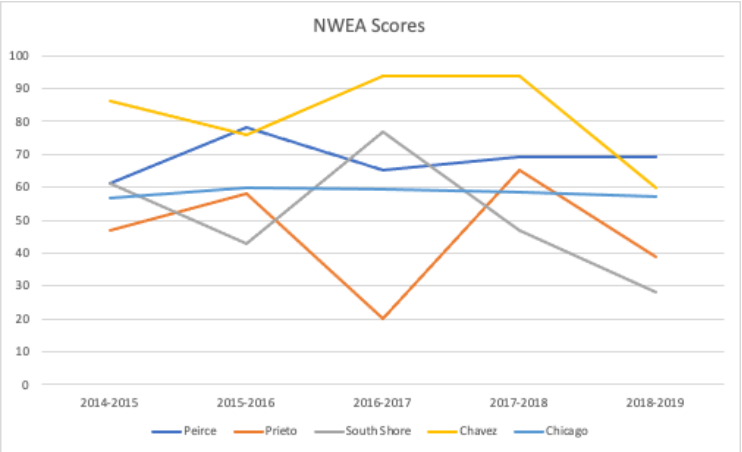
Source: Elaboration by authors

Figure 3 - SBAC Mathematics Proficient or Above 2014-19, School O (bars) vs. District (lines)



Source: Elaboration by authors

Figure 4 - NWEA Mathematics Scores 2014-19, District C Lesson Study Schools



Source: Elaboration by authors

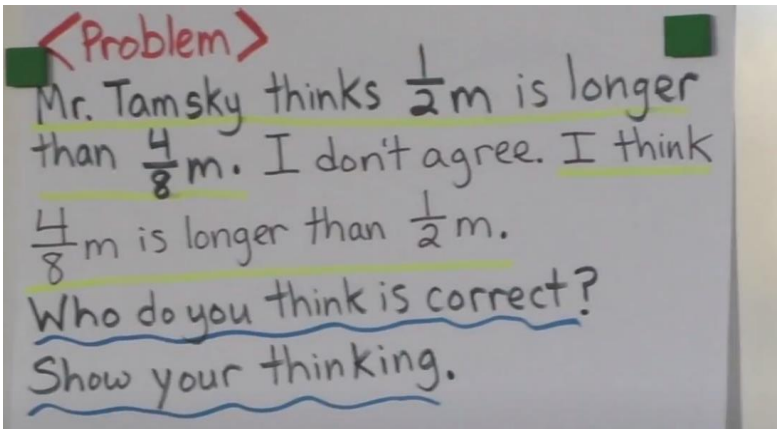
The potential of School-wide Lesson Study to solve two persistent problems in U.S. Education

Figures 2 and 3 suggest the potential of school-wide Lesson Study to address the persistent opportunity gap for students from low-income and historically marginalized communities in U.S. schools. Teaching Through Problem-solving (TTP), introduced as part of Lesson Study, was the major change in mathematics instruction during this period.

A TTP lesson typically focuses on a single problem that has been carefully designed to allow *students* to develop the targeted new mathematical procedure or concept from their prior knowledge as they work to solve the problem (Fujii, 2019; McDougal & Takahashi, 2014; Takahashi, 2021). Mathematicians reserve the term "problem" for tasks where a solution method has not previously been demonstrated; if a solution method has already been taught, the task is considered an "exercise" (Schoenfeld, 1985). Although U.S. mathematics educators have advocated for decades that "problem solving be the focus of school mathematics" (NCTM, 1980, p. 1), U.S. instruction continues to center on teacher-presented knowledge followed by student practice (Banilower et al., 2018). Teaching Through Problem-solving places great demands on *teachers'* mathematical content knowledge, since teachers need to grasp and respond to the mathematics in students' ideas, rather than simply show students the correct mathematical procedures. Transforming instruction typically requires repeated cycles of experimentation and refinement in practice. So a transformation like Teaching Through Problem-solving is very hard to achieve without a professional learning approach like Lesson Study that enables teachers to engage in repeated cycles of practice and reflection over time.

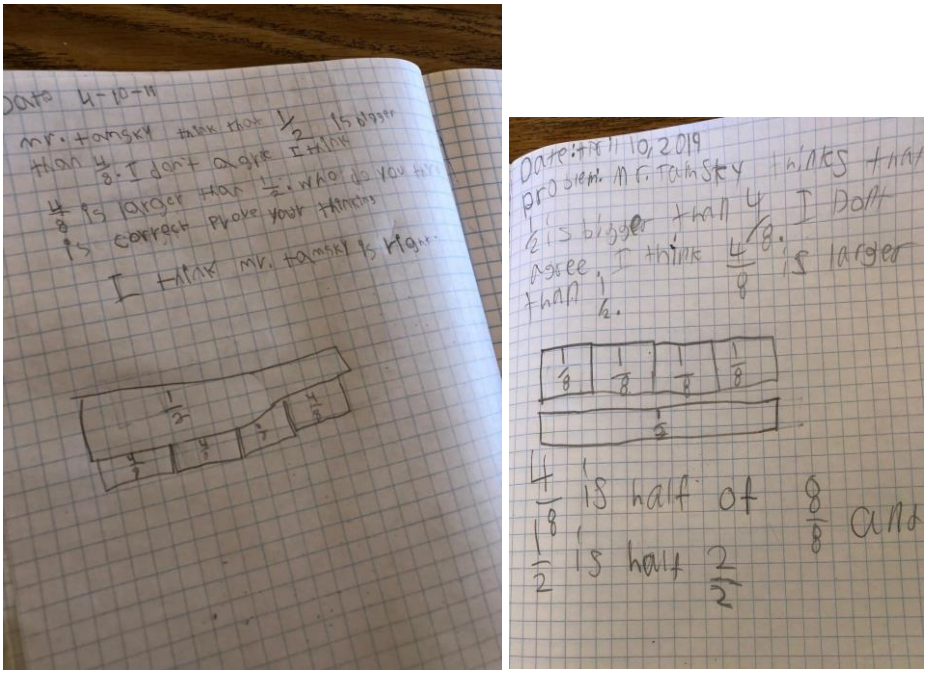
To illustrate TTP, Figures 5-8 provide artifacts from a 2019 research lesson at School S. The lesson instructor, Justin Stoddard, was in his fourth year of experimentation with TTP. The lesson revolves around a single challenging problem (see Figure 5) that allows students to build the new mathematical content–an understanding of equivalent fractions. Students initially grapple with the problem independently, working in their mathematics journals to devise a solution (Figure 6).

Figure 5 - Lesson task



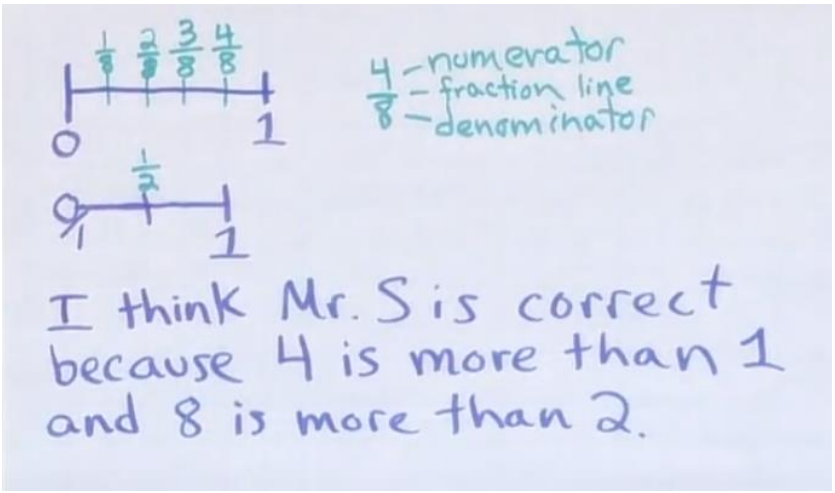
Source: Authors

Figure 6 - Student journals



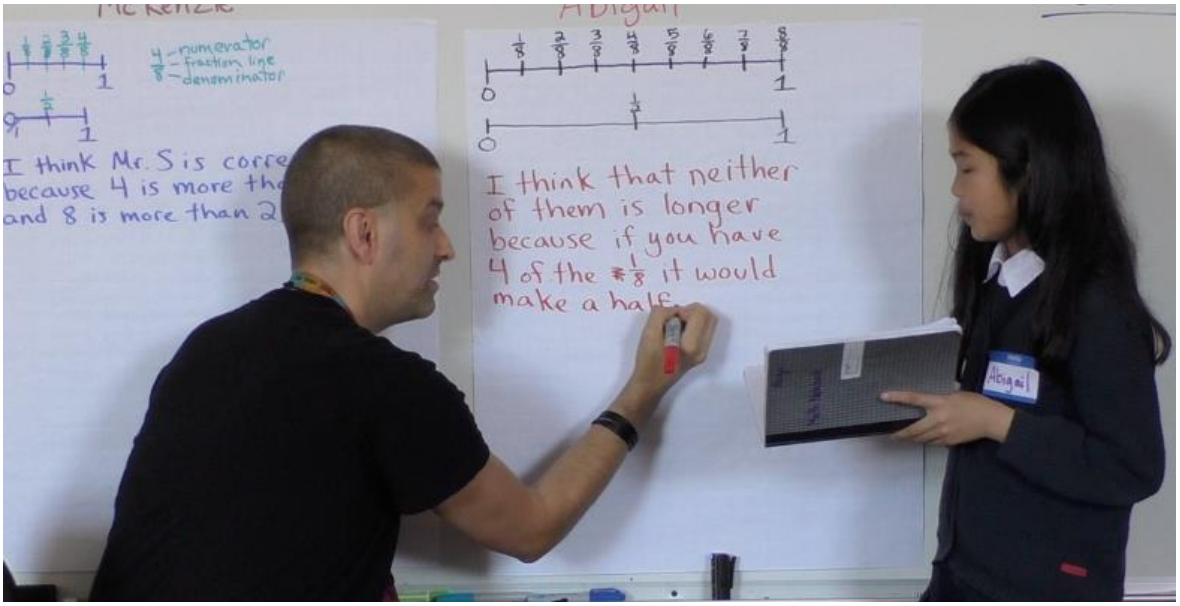
Source: Authors

Figure 7 - Student A's response, reproduced on board by teacher



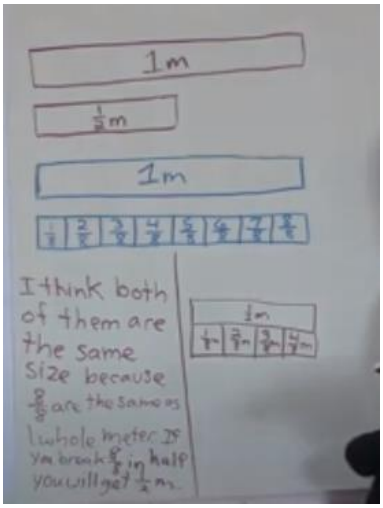
Source: Authors

Figure 8 - Student B's response, reproduced on board by teacher



Source: Authors

Figure 9 - Student C's response, reproduced on board by teacher



Source: Authors

Japanese teachers say that "the real lesson begins *after* the problem is solved," and about half the lesson was spent in whole-class discussion of the three pieces of student work shown in Figures 7-9, which students presented and explained, followed by questions from classmates. Each piece of work showed the student's name at the top (omitted for confidentiality) and, as Figure 8 shows, Mr. Stoddard reproduced their work at the board, directed by the students, who used their journals to guide the reproduction. The whole-class discussion elicited gasps and exclamations from students at several points. For example, a student asked Student A why she did not draw two same-length number lines, and Student A said she was not sure. Mr. Stoddard added "You're still thinking. That's OK." When Student B next presented work, a student asked why she used two same-length number lines, and Student B answered, "Because I wanted to make both of them one meter," provoking several loud "ohs" from classmates. Likewise, when a classmate asked Student C why she made 8/8 since the number in the problem is 4/8, Student C explained that she made the whole meter "because it is the same size as 8/8, and if you rip it in half it is 4/8"–provoking loud exclamations of "I get it" and even one "bravo!"

Table 3 provides a window on the change in mathematics teaching-learning at School S, by comparing the 2019 research lesson with a 2016 research lesson also planned by the grade 3 Lesson Study team when teachers were just beginning to experiment with TTP; two of four team members were the same in 2016 and 2019. Both research lessons focused on comparing fraction size and both were taught by Justin Stoddard. However, as Table 3 reveals, the lesson tasks differed substantially, changing from a series of "bare-number" tasks in 2016 to a single context-

embedded problem in 2019: proving whether 4/8 or ½ is greater. (The team deliberately chose to omit the problem's correct answer, to heighten the drama of the lesson.) In the 2016 lesson, before attempting the task themselves, students were handed a tool (fraction bars) and they watched a classmate solve the task (with a different fraction) on the board using fraction bars. In 2019, students devised their own strategies to solve the problem and choose their own tools. Established class routines of writing in mathematics journals, questioning presenters during whole-class discussion and using information from the boardwork enabled students to build the new mathematics largely through their own thinking, questioning, and discussion.

Table 3 - Comparison of 2016 and 2019 research lessons on fraction size

	2016	2019
Task	Worksheet of 8 same-format problems (with different fractions substituted for ⅜): "Explain why ⅜ is bigger, smaller or the same size as benchmarks (0, ½, 1)"	A single problem: "Mr T. thinks that ½ meter is longer than 4/8 meter. Mr. S thinks that 4/8 meter is longer than ½ meter. Who do you think is correct? Show your thinking."
Tool and Solution Method	Tool (fraction strips) is handed out by teacher; a number line and a solution method using the fraction strips is demonstrated by a student at the board before students try the task	Students are not given a tool or shown a solution method before trying the task; they draw on tools and ideas from prior lessons to independently develop solution methods
Work on Task	After brief independent work time, students work mainly in groups, sometimes telling each other the answers	Students work to solve the problem independently in their journals (17 minutes) before hearing classmates' ideas
Discussion of Work	Most discussion in table groups. Students exchange work and correct a partner's work; two groups complete a poster summarizing their work and show it to the class	Most discussion is whole-class, focused on three students' work presented on the board in large, legible print that can be read by all students

Presentation of Work	Groups *volunteer* to present their posters, which are not legible beyond first row; about 7 minutes is spent presenting posters	*Teacher strategically selects* three students whose work is reproduced on board, allowing side-by-side comparison; each student is questioned by classmates in whole-class discussion (20 minutes)
Examples of Student-to-Student Speech	Student speech focuses mainly on logistics and whether answers are correct. "Do you think we can get extra credit if we explain it in words?" "Do you get what we're supposed to do?" "You can change mine if our answers are different."	Student speech focuses on the mathematical models and concepts. "Why did you draw different length number lines?" "Why did you show 8/8 on your number line if the problem says 4/8?"
Reflective Mathematics Journals	Students used journals only to write reflections at the end of lesson.	Students used their journals to record the problem, work out a solution, take notes on classmates' solution methods, record the lesson summary agreed on by the class, and write reflections on what they learned or still wondered about. Several student reflections from the prior lesson are selected by the teacher to introduce each day's lesson.
Lesson Summary	No student-voiced summary, but students conclude from looking at presented work that some groups used fraction bars and some used number lines	Student-voiced summaries such as "Just because something sounds like it's longer than something else, it doesn't mean that it is," contribute to a class summary on board: "Sometimes two different fractions can be the same length, such as 4/8 and ½"

Source: Elaboration by authors

The comparison of the 2016 and 2019 lessons in Table 3 illuminates the shift toward problem-solving–a shift that has been notoriously elusive for U.S. schools, as noted earlier. In

2019, the students solved a challenging problem that allowed them to build a new mathematical idea (equivalent fractions) using their own and classmates' thinking and drawing on tools/models from prior learning; in 2016, students were *given* the tools to complete a series of tasks whose solution method had already been demonstrated. When asked to reflect broadly on the changes in his mathematics instruction between 2015 and 2019, Justin Stoddard said:

> One of the things that jumps out is that TTP lessons have naturally elevated the engagement of students. The big ideas are coming from each other, and there's this enhanced level of excitement when it's coming from another student. A couple weeks ago, we were looking at the area of irregular shapes, and one student came up with the idea of adding on to a shape to make a regular shape and then subtracting [the added quantity] at the end, and the class just erupted into "Oh my god." If I had been doing direct instruction and showed them "this is how you do it; now you practice" it would have been nothing. They've really held on to that strategy, and days later they're saying "I really want to try Edwin's idea."

Principles underlying successful school-wide Lesson Study

Not every site that tries to build school-wide Lesson Study is able to do so. We next discuss two principles that underlie the work of successful school-wide Lesson Study sites: support for teachers' intrinsic motivation; and joint teacher-administrator leadership.

Support for teachers' intrinsic motivation

Self-determination theory and research establish that settings that meet three basic human needs–autonomy, social relatedness, and competence–elicit participants' intrinsic motivation and commitment (Deci & Ryan 1985; Ryan & Deci, 2000). Lesson study responds to these three basic needs of educators. For example, educators' own questions and vision shape Lesson Study (autonomy). Team members work together and support each other by exchanging ideas, co-planning, sharing lesson observations, making sense of new ideas, and celebrating the team's work (social relatedness). Cycles of study, planning, observation and reflection build teachers' skill as teachers and observers and their knowledge of teaching, learning and content (competence). Justin Stoddard's description of the changes at School S with school-wide Lesson Study illuminates how both autonomy (choosing the focus of the work) and social relatedness support teachers' work to improve instruction:

> I can go to colleagues and say hey I'm struggling with this. If I know that my discourse is too teacher-student-teacher-student…I can go to my colleagues because we're all engaging in the same type of work. I can take advantage of what they've learned….The wealth of knowledge is within each other. We see that and learn from that directly, rather than gambling on some outsider to come in and share information….It is collectively building on the wisdom and experience that we all bring to the school site community.

In talking about the changes that came with school-wide Lesson Study at School O, Hanna Sufrin referred to the "fun" and "depth" and "juicy math conversations" that came with school-wide Lesson Study.

> The nature of the conversations and really getting into one another's teacher brains just kicked off a different way of seeing one another as fellow learners. You realize everyone at the table has something big to offer. And that's pretty exciting. Wanting to learn together has to be one of the key levers in actually getting teachers to shift their practices. So once we felt like this was really fun work, that we were inspired by everyone at the table, and we realized we all wanted to grow together, then we're holding each other accountable. So Lesson Study made us see one another as colleagues in a different way.

Sufrin notes that much non-Lesson Study professional development (PD) does not provide sufficient time or an effective design for teachers to really learn together. It feels "scattered: Math PD one week, English the next week; it's really hard to feel focused with so much going on."

> So then you take Lesson Study and you say every week you are going to meet only on this one specific topic within this content area. You drill way down, zoom in. Those conversations were so much more focused than anything we had ever done together as a group of teachers. It was the opportunity to say: this is all we're doing for the next eight weeks, and let's put everything else to the side for the next 2 hours.

Focusing on the whole unit during a Lesson Study cycle, and studying the standards in depth, allowed "really deep conversations about how to break up the objectives of the overall unit."

> People are always amazed when they look at the standards for a unit and realize that though it's 35 lessons, it's actually just, for example, four main Common Core Standards. And so doing that work of choosing for ourselves how to break down those standards, rather than just saying "oh, tomorrow's lesson says the kids have to learn how to do blank." A big shift that I made was working from the standards rather than working from the curriculum.

Sufrin says that the deep study of the standards, content and the whole unit during a Lesson Study cycle enabled her to shift her planning from a single lesson focus to the whole unit, making it much easier to identify the problem-solving experiences that would enable

students to learn the unit content. Students' responses to successful problem-solving lessons motivated her to keep investing in problem-solving:

> Because wow, a great TTP lesson feels so powerful for the kids. It's all over their journals, it's all over their faces. It's so obvious. And every time that we had one, it just made me want to do double the following week. I saw the growth in so many ways. I could see the progress in their journals and every piece of qualitative and quantitative data. Of course, that's what makes you want to keep going with anything in your classroom.

Each site made decisions about Lesson Study scale-up in ways that respected teachers' autonomy, social relatedness and competence. For example, at School S, just five teachers initially volunteered for Lesson Study, so the work began with just one cross-grade team of five teachers. Site leaders did not urge other teachers to participate, but did involve the whole faculty in creating the vision for student success and theory of action, so all teachers would feel invested in the cross-grade team's work on the vision. Over time, the cross-grade team invited the whole faculty into many elements of the work, such as joint study of resources related to the vision and observation of research lessons. By the time the whole faculty was expected to join Lesson Study teams two years later, they felt connected to the work and had seen the positive response of their colleagues who originally volunteered. As Justin Stoddard, a member of the original cross-grade team, later noted:

> One of the things that made the progression to whole-school Lesson Study more successful was the gradual transition–we started with the teachers who were passionate and interested in exploring the process…and then they became the team leads as we transitioned to whole school. Rather than coming top-down from administration, when other teachers were hearing from the pilot teachers about why this is such a powerful practice, it's received better.

At School CE, Lesson Study spread slowly over more than five years. Most teachers in the K-5 grades are involved in Lesson Study in some way, but research lessons are typically observed by just a few teachers outside the team, not the whole faculty. Josh Lerner, whose work over time has included lead math teacher and lead bilingual teacher, initially nurtured colleagues' interest in Lesson Study in many ways, including by volunteering to teach in other teachers' classrooms:

> I've often volunteered to go and teach a lesson in a classroom if I know a difficult topic is coming up, and I'll treat it a little bit like a research lesson, giving people a plan ahead of time. I'd invite people and try to arrange some substitute coverage, make it easy on them to participate, and then give some rationale for the lesson design, to show them that I put some work into thinking about this and what I think is interesting to observe and think about. We wouldn't always have a post-lesson discussion officially, but I would try to find a time to check in with people afterwards. I definitely remember getting really good feedback from certain people saying that it was a real highlight for them to be able to just go into another classroom and see something that they found interesting and be able to talk about it afterwards. Actually, that was one of the ways that I started getting a few more people involved in research lesson cycles was first by just inviting them to that experience because it's pretty low stakes for them.

When asked about the experiences that led School CE teachers to go deeper with Lesson Study, Josh Lerner mentioned the power of summer institutes, large public research lessons, and celebrations following research lessons, which are "really motivational for people….they've built a relationship with each other about a shared interest or practice. Honestly, the *kanpai* (celebrations) are influential; they reinforce the bond that people have made about teaching and their students."

Teacher-Administrator joint leadership

School-wide Lesson Study requires two different kinds of leadership that are hard to engineer together: *teachers' leadership* of the day-to-day Lesson Study work and *administrators' leadership* in protecting and resourcing teachers' work. Teachers need to lead the work of *doing* Lesson Study, because the work needs to evolve in response to teachers' emerging needs and questions–something likely to be possible only if teachers hold day-to-day leadership. The School S Principal had tried to introduce school-wide Lesson Study at a prior school, but it did not get taken up by teachers. When asked if he wanted to try to build it at School S, he answered "If teachers buy in." A Teacher Leader Fellow at School S who was experienced in Lesson Study worked closely with the principal to lay the groundwork to build teachers' buy-in.

At all three case sites, one or more teacher-leaders were actively involved in leading Lesson Study. School O had a strong tradition of teacher leadership since its 2003 founding. A lead instructional team of six teachers met bi-weekly with the principal to discuss and decide instructional issues. When the mathematics leads on this team became interested in Lesson Study and TTP, it was natural for them to initiate these, since there was already an expectation that teachers would suggest and lead changes in instruction. It required only a modest re-design

of the weekly professional learning time (2 hours on an early-release day) to build in Lesson Study cycles of 6-8 meetings for each grade-band.

At School S, the Teacher Leader Fellow recruited a cross-grade team of volunteers interested in Lesson Study, and this team conducted Lesson Study cycles and experimented with TTP for two years before having each member become a facilitator of a grade-band Lesson Study team. The cross-grade team then became a strategic leadership team for Lesson Study, meeting bi-weekly to plan next steps in Lesson Study work based on their collective knowledge of every team in the school. At School CE, Lesson Study began with a mathematics lead teacher; teacher leaders to facilitate additional teams emerged gradually over time as teachers saw the usefulness of Lesson Study and TTP. Prior to the closure of in-person schools due to the pandemic, the teacher leaders met monthly to coordinate their efforts collectively as a Lesson Study Steering Committee. School CE is now making an effort to reinitiate this committee.

Administrators create the organizational space for teachers' leadership to emerge and they ensure teachers' access to high-quality knowledge resources. At all three schools, the principals created and protected the space for teachers to experiment with Teaching Through Problem-solving. This looked different at each site, but included actions such as getting exemptions from district initiatives that would impinge on teachers' time, supporting curriculum waivers for materials to support problem-solving, finding high-quality resources to support teams' study and identifying outside mathematics specialists to comment on draft research plans and to observe and provide final commentary on research lessons.

To summarize, building Lesson Study school-wide required coordinated leadership from teachers and administrators. Teachers were positioned to pick up colleagues' responses to the unfolding Lesson Study work and adjust the work in response to teachers' questions and concerns; site administrators were positioned to protect teachers' time to conduct Lesson Study, to ensure their access to high-quality mathematical and instructional resources and expertise, and to run interference when teachers asked, for example, to use resources beyond the district curriculum.

The principles of intrinsic motivation and integrated teacher-administrator leadership mean that Lesson Study typically took several years or more to spread school-wide. School O had a pre-existing tradition of teacher instructional leadership and instructional autonomy that allowed TTP and school-wide Lesson Study to be integrated into professional learning during

the first year of their work. At School S, the work spread school-wide after two years of work by a single cross-grade Lesson Study team to lay the groundwork. In both cases, teachers and administrators worked together to plan the work and continuously adjust their plans based on teachers' ongoing responses. At School CE, a math lead teacher was hired to facilitate Lesson Study cycles and build capacity among teacher leaders to lead their own cycles, so teachers came to see Lesson Study as a process led by teachers themselves. Over time, teachers came to regard the principal as a visionary school leader who trusted teachers with responsibility for professional learning by prioritizing Lesson Study–an approach that respects teachers' collaboration, autonomy and self-motivation.

Collective efficacy

"Collective efficacy" is typically measured through teachers' responses to items such as "How much can teachers in your school do to produce meaningful student learning?" and agreement with items such as "Teachers in this school have what it takes to educate students here" (Goddard, Hoy & Hoy, 2004). Teachers' collective efficacy is an astonishingly powerful predictor of student achievement–more than three times as powerful as student socioeconomic status, parental involvement, or student motivation and persistence (Hattie, 2017).

Why does teachers' collective efficacy have such a powerful relationship to student achievement? When teachers think they are well-positioned to impact student learning, they probably act in accordance with that perception–working hard to persist against any obstacles that threaten student learning. They may also build strong norms that expect all colleagues to persist in improving student learning.

Collective efficacy is higher among teachers who feel more influence over instruction-related school decisions such as professional learning and curriculum (Goddard, 2002). Lesson study can give teachers greater influence over professional learning and curriculum–for example, as they build a school-wide vision and theory of action for their work, revise instruction to reflect what they learn from content study, and use their own first-hand observation of research lessons–rather than externally imposed mandates–to guide instructional improvement.

Collective efficacy is also enhanced by experiences that allow teachers to see the link between their collective actions and student outcomes (Donohoo, Hattie & Eels, 2018). Lesson

study provides many such experiences. For example, School S Lesson Study teams reported that studying mathematics research enabled them to better anticipate and respond to students' mathematical thinking. School S teachers also noticed positive changes in their own and colleagues' classrooms after testing academic conversation supports related to their school theory of action. Teachers at all three sites observed, during research lessons, the power of new classroom routines such as planning the information to be presented on the board.

Teachers also built efficacy *vicariously*, by seeing colleagues succeed (Goddard et al., 2000). For example, a School S teacher was motivated to use reflective mathematics journals after seeing their power for students during a large public research lesson in District O. Direct and vicarious efficacy experiences both build collective efficacy. Justin Stoddard explains how school-wide Lesson Study enables teachers to join forces around school-wide instructional priorities:

> When we're engaging in whole school Lesson Study, the depth of conversation around the mathematics increases. It helps us become more thoughtful about what we want to prioritize and what we want to hold as vital parts of instruction in different units, because we're having these collective conversations about what number sense looks like in Kindergarten through fifth grade. Whole school critical conversations around standards, content, and instruction enable us to see the progression of standards and allow important patterns to emerge about student learning and impactful instructional moves. It helps us understand how much of an impact our own instruction has on students throughout the grades.

Challenges to School-wide Lesson Study and Teaching Through Problem-solving

This section addresses several challenges encountered by the three schools as they worked to build school-wide Lesson Study and Teaching Through Problem-solving.

How to encourage colleagues' participation while respecting their autonomy. Josh Lerner reflects on this dilemma:

> One of the main tensions for me at our school has been to what extent to push others to get involved versus to organically spread through relationships to let it grow naturally. Over the six years, we definitely have a growing number of teachers who are doing it or interested in it. But that number has grown slowly over time. I do think that's the best way in the end. Everyone who's gotten more involved has done it through relationships with their coworkers or through genuine interest. And so the experiences for basically everyone have been positive and motivating to continue. But the flip side of that is that it's been incremental. It's been pretty gradual.

Educational administrators often expect immediate results, and many initiatives are discarded if they do not produce results rapidly. So schools may not be given the time to build

participation in ways that respect teacher autonomy. As Figures 2 and 3 reveal, standardized test scores at School S and School O both showed slight dips from baseline (2014-15) to the first project year (2015-16) for most subgroups. An initial performance dip is typical for innovations that require teachers to develop new skills and understandings; how educational administrators respond to the performance dip can play a critical role in a reform's success or failure (Fullan et al., 2005).

Hanna Sufrin, in a subsequent position as an assistant principal at another District O school, used teachers' own curiosity as an entry point for an introductory Lesson Study-TTP experience. A group of teachers interested in bringing out student voice and getting kids to be doing more of the mathematical thinking volunteered to watch and discuss two TTP lessons (LSGAMC, 2020b).

> It made the teachers very curious. And there were all these amazing concrete next steps that came out of it–every teacher having a few things they wanted to start doing. For example, teachers loved the idea of the journals. They wanted to bring kids up to the board and write their name when it's their idea so the kids start to realize that their ideas matter. Each teacher brought three or four of those types of strategies back to their room.

Teacher turnover. Although School S has generally had much lower teacher turnover than other District S schools, there was considerable teacher turnover during the pandemic and some teachers new to the school did not see the value of having all teachers work on the same subject (mathematics). Teachers were then given a choice of subject area focus for their Lesson Study work, but the Lesson Study leadership team found that working on different subjects diminished the quality of cross-grade conversations about alignment: "If you are going to build in choice, you need to build in ways to learn from each team's learning." After a year of working on multiple subject areas, School S returned to a school-wide mathematics focus.

Logistics of scheduling meetings. Another challenge to building and sustaining school-wide Lesson Study is the logistical complexity of bringing together teachers in the same place at the same time for Lesson Study activities. School S and School O are relatively small schools (around 300 students), but School CE is larger. At School CE, the lead math teacher works closely with the principal and school clerks to determine the number of classrooms that can be handled by substitute teachers so that staff members can participate in Lesson Study meetings and research lessons. Leaders make sure to distribute the Lesson Study work across the school year and across grade levels. By the end of each year, a representative cross-section of the school

faculty have participated in research lessons and have gotten a chance to share their learning, either formally or informally, in order to broaden impact.

Need for curriculum updates and a broader Lesson Study ecosystem. In Japan, teachers' learning from Lesson Study ripples throughout the country, since Lesson Study takes place in many different settings, and educators carry their learning across settings (Lewis, 2015; Lewis & Tsuchida, 1997). Classroom teachers, university-based content specialists, district administrators, textbook authors and national policy-makers attend research lessons and transport ideas across settings (Lewis & Takahashi, 2013). For example, elementary teachers who are especially interested in mathematics teaching might take part in a district-based mathematics Lesson Study group, and might attend research lessons at the district level, at university-affiliated lab schools or at meetings of regional and national mathematics education associations, bringing back ideas to the Lesson Study work at their school. Effective approaches reshape textbooks (since the teachers and university-based educators who write textbooks are active in Lesson Study) and reshape the National Course of Study. For example, solar energy was added to the National Course of Study after classroom teachers pioneered it in local Lesson Study, with the goal of adding a more ecologically friendly approach to the curriculum's content on conventional batteries (Lewis & Tsuchida, 1997).

In the U.S., we lack such an ecosystem where approaches like Teaching Through Problem-solving will reshape textbooks once educators see the effectiveness of a new approach. Japanese textbooks are specifically designed for students to build each new procedure or concept using their prior learning, and they provide support for students to learn to make their thinking visible in reflective mathematics journals (LSGAMC 2022d, Watanabe, 2014). When asked about where to begin with Teaching Through Problem-solving, Josh Lerner suggests:

> With Teaching Through Problem-solving, I think it's very difficult to do without a good task or curriculum as a starting point. When I wanted to tackle an important topic, such as division in third grade, I chose the unit from the Tokyo Shoseki curriculum to do as a whole unit and then return to the school's adopted curriculum. I tried out Teaching Through Problem-solving (by) participating in research lessons (and by) having a unit I knew I could trust, where I could see the progression of learning. I think that's a really strong way to try problem solving-based teaching–to have something you can base your teaching on, even if it's not your core curriculum.

Hanna Sufrin also noted the initial challenge of designing problems for TTP lessons before she had learned how to study the whole unit and the related Common Core Standards.

> Our batting average was about 50% with our TTP problems. One day we would try one and have this absolutely gorgeous TTP lesson where we would feel euphoric after it worked and the learning was so obvious. And then two days later, another story problem would completely fall flat on its face, and we would look back at it and realize that it was not a successful problem to pitch to kids. We always felt pretty alone in that process– just trying things out and seeing what worked. And it's pretty intense to be doing that with real children whose real math learning is at stake.

U.S. curricula vary vastly in their capacity to support student-led problem-solving, and in many districts teachers are expected to follow the district curriculum as written, especially during the early years of a new curriculum adoption, when all teachers are expected to give the new curriculum a chance to work. At School O, the principal had freedom to innovate in the curriculum because he had been in the district for a number of years and was well-respected; also, the mathematics curriculum had been in use for a number of years and had not improved test scores. A School O teacher pointed out that the principal would not have had the freedom to innovate if he had been in the early years of his principalship, "and the average tenure for a principal is only about three years." School S and several other schools using TTP petitioned for a curriculum waiver to use Japanese materials; their growth in test scores, the low teacher turnover rate and teachers' advocacy (through the Teacher Leader Fellow network) probably contributed to a favorable response to the waiver request and to the district's decision to study the work at these schools.

Surviving changes in school leadership. Another challenge is maintaining Lesson Study through changes in school leadership. When the School S principal decided to leave the district, the Teacher Leader Fellow who had been co-leading the school-wide spread of Lesson Study stepped up to become the interim principal and then principal (after obtaining the needed credential). Despite the Teacher Leader Fellow's reluctance to leave the classroom, she took on the principalship in order to ensure that the progress at the school would not be reversed by a change in leadership. At several other sites, school-wide Lesson Study did not survive a change in principals.

A Teacher-Leader Network as a resource for school-wide Lesson Study. The Teacher Leader Fellowship in District S creates a network of Lesson Study Teacher Leader Fellows that is somewhat insulated from changes at individual schools. The District's Office of Professional Learning and Leadership (OPLL) selects Teacher Leader Fellows from experienced teacher-applicants who want to develop expertise as Lesson Study facilitators while remaining classroom teachers at their sites. These Teacher Leader Fellows (TLFs) receive a

salary bonus, extra substitute hours, online Lesson Study resources and mentoring. TLFs also meet monthly as a Network to share emerging learnings from their site-based work and to discuss challenges. The funds for the Teacher Leader Fellowships come from a special voter-approved initiative designed to retain experienced teachers in the district. Because the funds are voter-approved and cannot generally be used for other purposes, they are somewhat insulated from budget pressures.

The Teacher Leader Network seems to make school-wide Lesson Study somewhat more resilient in District S than in the other two districts, since teachers have access to support and resources outside their school. Teachers have collaborated in cross-site public research lessons, worked together to petition for a curriculum waiver, and worked together to bring additional schools into the work.

Teaching Through Problem-solving resources and expertise. Teachers from all three schools mentioned outside resources and partners as valuable supports to their work. The partners included both Japanese and U.S. educators who were knowledgeable about Lesson Study and the in-depth content study that it entails, as well as the vision of TTP that students will build the new mathematics in the curriculum. Support included expert final commentators for research lessons, partnering with an outside facilitator for a Lesson Study cycle, and high-quality curriculum resources.

Summary

This chapter briefly describes school-wide Lesson Study, an approach that is ubiquitous in Japanese elementary schools but rare in the U.S. We look at three U.S. sites that have used school-wide Lesson Study in conjunction with Teaching Through Problem-solving. Growth in mathematics learning at the school-wide Lesson Study sites is substantially greater than in other district schools, largely eliminating the learning gaps for historically discriminated groups. (Standardized tests allow in-depth assessment of mathematics at only two of the three sites.)

Two principles seem to characterize successful school-wide Lesson Study development: (1) attention to the conditions that support teachers' intrinsic motivation; and (2) integrated teacher-administrator leadership. The cases also suggest the power of combining school-wide Lesson Study–a powerful set of routines for teachers' development of professional knowledge–and Teaching Through Problem-solving – a powerful set of routines for student mathematics

learning. Finally, the cases surface a number of challenges in building and sustaining school-wide Lesson Study and transforming mathematics instruction. These include building school-wide involvement while respecting teachers' autonomy; surviving changes in school leadership; and refining curriculum to support problem-solving.

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Autores

Catherine C. Lewis
cclewis150@gmail.com
https://orcid.org/0000-0002-0557-0876
Mills College at Northeastern University
Oakland, CA
Justin Stodard
stoddardj@sfusd.edu
https://orcid.org/0009-0001-1492-5974
John Muir Elementary School (SFUSD)
San Francisco, CA
Joshua D. Lerner
lerner.joshua@gmail.com
https://orcid.org/0009-0006-4319-461X
Helen C. Peirce School of International Studies, Chicago Public Schools (CPS)
Chicago, IL
Hanna A. Sufrin
hannasufrin@gmail.com
https://orcid.org/0009-0005-3148-4241
Oakland Unified School District (OUSD)
Oakland, CA

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