

Lesson Study

PARTICIPANT GUIDE

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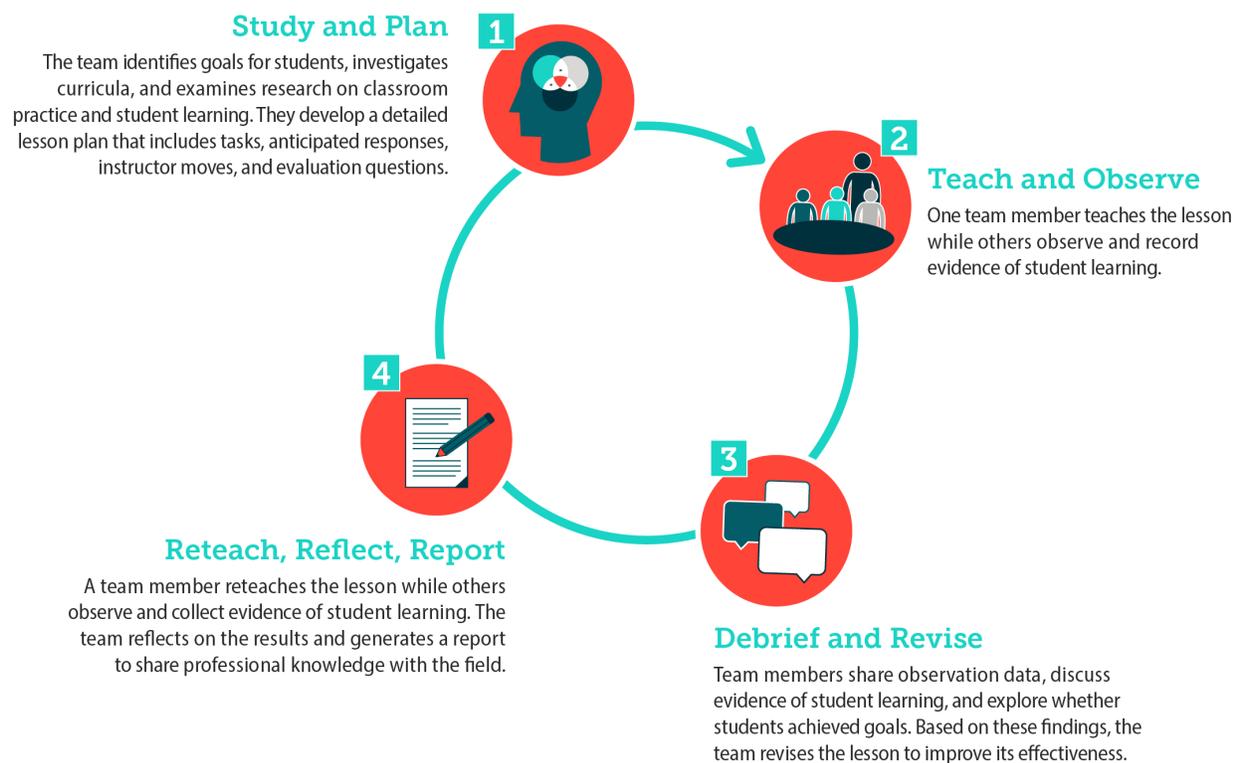
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Introduction

What is lesson study?

Lesson study is an approach to professional development that brings the intricacies of teaching practice and student learning into focus through collaborative and sustained examination of curriculum and instruction. Working in iterative cycles, lesson study gives instructors a framework for actively investigating how to improve learning in their classrooms. Participants undertake four stages during each lesson study cycle: (1) Study and Plan, (2) Teach and Observe, (3) Debrief and Revise, and (4) Reteach, Reflect, and Report (See Figure 1).

Figure 1: Lesson Study Cycle



DISCUSS

- Think about professional development experiences in which you have engaged in the past. Which ones were effective? What made them effective?
- In what ways did they affect your instructional practice? Were there any impacts on student learning?
- How is lesson study similar to or different from other professional development experiences in which you have engaged? What resonates with you? What questions do you have about the lesson study cycle?

How does our team realize the benefits of lesson study?

Three implementation practices (Figure 2) are critical for teams to realize the purpose and benefits of lesson study. The **first** practice is to develop and sustain a collaborative team by creating a productive learning community. Establishing and sustaining a safe and trusting environment with clear communication will support the team as it engages in inquiry, reflection, and critical examination of its practice. The **second** feature of lesson study is to study research and apply evidence-based practices. Lesson study involves posing questions and problems of practice, researching possible solutions, trying out ideas, collecting data, and analyzing findings. Without this emphasis, lesson study can devolve into a superficial or perfunctory experience in which participants refine lessons in minor ways without new learning. The **third** implementation feature is to generate and share professional knowledge. If the time invested in lesson study is to have long-term benefits, learning must be made explicit and shared.

Figure 2: Implementation Practices



DISCUSS

- What prior experiences have you had working collaboratively with colleagues? What went well?
- In what ways do you use research on student learning?
- What types of instructional practices have you found to be most helpful in your courses? What types of evidence-based instructional practices would you like to get better at?
- How do you share your professional knowledge with others?

Routines for Lesson Study

Your team can take several steps to ensure that your lesson study cycle goes smoothly. Documenting team thinking and learning, assigning roles for meetings, and creating and communicating timelines will help your team stay organized and maximize the learning experience for all.

Document Team Thinking and Learning

Recording your team’s thinking and learning along the way will support your effort to generate and share professional knowledge. In addition to a printed and PDF version of this Participant Guide, there are additional electronic documents available in Google Docs and Microsoft Word to capture your team’s work.

The following symbol  will indicate where to record your team’s notes for each step.

Step	Team Notebook 	Lesson Plan 1 	Lesson Plan 2 	Final Report 
Routines for Lesson study				
Step 1. Develop Collaboration Norms				
Step 2. Establish a Research Theme				
Step 3. Identify and Study the Topic				
Step 4. Plan the Lesson				
Step 5. Prepare to Teach and Observe				
Step 6. Teach and Observe the Lesson				
Step 7. Debrief and Discuss Observation Data				
Step 8. Revise the Lesson				
Step 9. Reteach, Observe, and Debrief				
Step 10. Reflect and Report				

Define and Assign Roles for Each Meeting

Assigning group roles for each meeting will help the time go smoothly, ensure that the team stays focused, and support the team with documenting key ideas and decisions.



DISCUSS

- What roles should we have during each session to ensure that we stay focused and work effectively as a team?



EXAMPLE ROLES

- *Facilitator*: ensures that the team stays focused and works efficiently to meet its objectives
- *Recorder*: documents key ideas and decisions made by the team in the team notebook or lesson plan
- *Process watcher*: observes team interactions, including how well collaboration norms are followed, and reports back during and/or at the end of the session
- *Timekeeper*: helps the team stick to its schedule



OUR TEAM'S ROLES



Team Notebook: Roles

Create and Communicate a Timeline

Your team will engage in 10 steps to complete a cycle of lesson study. It's helpful to create and communicate an outline and timeline for the work.

Figure 3: Team timeline

STUDY AND PLAN	EST. TIME	DATE AND TIME	LOCATION
Step 1 Develop Collaboration Norms	30 minutes		
Step 2 Establish a Research Theme	1 hour		
Step 3 Identify and Study the Topic	2 hours		
Step 4 Plan the Lesson	3–6 hours		
TEACH AND OBSERVE			
Step 5 Prepare to Teach and Observe	1 hour		
Step 6 Teach and Observe the Lesson	1–2 hours		
DEBRIEF AND REVISE			
Step 7 Debrief and Discuss Observation Data	1 hour		
Step 8 Revise the Lesson	1–3 hours		
RETEACH, REFLECT, AND REPORT			
Step 9 Reteach, Observe, and Debrief	2 hours		
Step 10 Reflect and Report	1 hour		



OUR TEAM'S TIMELINE



Team Notebook: Timeline

10 Steps to Lesson Study

10 Steps to Lesson Study

As outlined in the introduction, a Lesson study Cycle consists of four stages and three implementation practices. Your team will engage in 10 steps to complete your first lesson study cycle.



Figure 5: Implementation Practices



1 Develop Collaboration Norms

The lesson study team establishes collaboration norms, or common agreements, on what group members need from each other to feel supported, productive, and trusting. These agreements can help a team do its best work. Establishing five to eight collaboration norms works well. These should also be revisited at the start of each new cycle.

ROLES

Facilitator

Recorder

Process watcher

Timekeeper



DISCUSS

- What are our expectations for how our team will work together?
- What relational conditions – how we relate to each other and create/maintain a sense of belonging and support – will contribute to our learning?
- What operational conditions – procedures and structures guiding our work – will contribute to our learning?
- What conditions would get in the way?
- How will we resolve differences and/or disagreements?



EXAMPLES

- Be fully present – Listen attentively, focus on the person speaking and what they are saying, avoid side conversations, and participate.
- Keep focused on the work – Give specific descriptive feedback that is nonjudgmental.
- Be respectful – Use “I” statements. Share the air. Suspend your assumptions. Agree to disagree, recognizing that differences in perspective exist. Make space for everyone’s ideas.
- Don’t rush to solutions – Lead with inquiry.
- Make this a safe place – Be mindful of the need to nurture risk-taking and honesty.
- Practice good humor – Have fun, build community with social activities, and laugh together.



OUR TEAM’S COLLABORATION NORMS



Team Notebook: Collaboration Norms

2 Establish a Research Theme

The lesson study team discusses ideal and actual student qualities and traits, then uses this discussion to establish a research theme: a broad, long-term goal focused on students that provides a common focus across multiple cycles of lesson study and related professional development experiences. Teams that are keeping the research theme they used previously can skip this step.

ROLES

Facilitator

Recorder

Process watcher

Timekeeper

DISCUSS

- Ideally, what affective qualities and traits do we hope our students will have when they complete the mathematics pathway?
- What are students' current qualities? What characteristics inspire us? Is there anything that concerns us?
- What are the gaps between the ideal and the actual? What ideal student qualities do we want to develop?

EXAMPLES

- How can we develop students' capacity to ask for clarification, communicate their thinking process, and justify their solutions?
- How do students develop and recognize their willingness to engage in mathematics? Their curiosity? Their persistence? Their confidence?
- How do we build students' confidence in their mathematical reasoning and willingness to persevere in problem solving? Promote a productive disposition? Support a growth mindset? Embrace and learn from confusion?



OUR TEAM'S RESEARCH THEME



Team Notebook: Research Theme

3 Identify and Study the Topic

The team reviews course content, student learning challenges, and other data/information to pinpoint a broad topic for the research lesson. The team examines the identified topic in the curriculum, with attention to the goals, sequence of lessons, and progression of the mathematical concepts in the text or materials. The team selects one lesson to be the focus of the lesson study cycle.

ROLES

Facilitator

Recorder

Process watcher

Timekeeper



DISCUSS AND RECORD AS YOU GO

Lesson Plan 1, Section A

- What topics are important and persistently difficult for students to learn?
- What key concepts should students understand about this topic? What do we want students to understand by the end of the course?
- How does our text treat this topic? How does each lesson or task help build conceptual understanding? Does the sequence of lessons align with the learning progressions?
- What does the research say about this topic? What are common student challenges and misconceptions?
- Which lesson addresses a concept that is critical to the topic? Which lesson should serve as the focus for our lesson study?



EXAMPLES

Lesson plan examples can be found at:

http://www.lessonstudygroup.net/lg/lesson_plans_table.php?clsg=1



OUR TEAM'S BACKGROUND AND RESEARCH ON THE TOPIC

Lesson Plan 1, Section A

4 Plan the Lesson

The team collaborates on planning a lesson to help students meet the learning goals and to ensure instructors gain knowledge about the research theme. The team studies evidence-based instructional practices and considers how they should be incorporated into the lesson. The plan is detailed and represents the team's research and its collective thinking about how best to foster student learning. Be sure to record your team's ideas and decisions in Lesson Plan 1, Sections B through I.

ROLES

Facilitator

Recorder

Process watcher

Timekeeper



DISCUSS AND RECORD AS YOU GO

 *Lesson Plan 1, Section B through I*

B. Student Learning Outcomes for the Lesson

- What do we want students to understand and be able to do by the end of the lesson?

C. Rationale for the Design of Instruction

- What evidence-based instructional practices will help us address our research theme and student learning goals for this lesson?
- How does the lesson flow? What is the sequence of experiences that will propel students from their initial understanding to the desired understanding?

D. Selecting Learning Tasks and Activities

- Which tasks will be included in the lesson?
- In what ways does the task build on students' previous knowledge, life experiences, and culture?
- What is the cognitive demand of each task?
- Do the tasks attend to the research theme and student learning goals?

E. Anticipated Student Responses

- What are all the ways the tasks can be solved? What student responses do we anticipate?
- How can their thinking help drive the lesson?

F. Instructor Support

- How will we ensure that students remain engaged? How will we support students if they are stuck or frustrated?
- How will we assess and advance their thinking? How will we extend the tasks if students finish early?

G. Comparing and Discussing

- How will we orchestrate class discussion so that we accomplish our learning goals? How will students share their thinking?
- What strategies or solution paths do we want students to present? How will we support students to engage with, make sense of, debate, expand on, and make connections with each other's thinking?

H. Summing Up

- How will we summarize the main ideas of the lesson and loop back to the learning goals?
- What will we do tomorrow that will build on this lesson?

I. Assessment

- What types of data will be informative for our team to collect during the lesson?
- How will we know the extent to which the student learning goals were met?



OUR TEAM'S LESSON

 *Lesson Plan 1, Section B through I*

5 Prepare to Teach and Observe

Preparing to teach and observe ahead of time ensures this step will go smoothly. In advance of the first teaching session, your team will create a checklist of items to attend to and will record them in your Team Notebook. Your list may include the items below.



EXAMPLE CHECKLIST

- Reserve a room for debriefing
- Send observation and debriefing times and locations to observers
- Make and distribute copies of the lesson plan and any handouts
- Prepare student names tags
- If needed, schedule and convene a pre-observation meeting for non-team members



OBSERVATION PROTOCOL

Establishing and communicating protocols for observers will clarify their role during the teaching of the team's lesson. Observers will be expected to:

- **Collect data requested by the lesson planning team.** Be prepared by reading the lesson plan closely prior to the observation. Focus on the “points of evaluation” and questions outlined by the team. Stay present and record observations on the lesson plan handouts.
- **Respect the classroom atmosphere and natural flow of the lesson.** Refrain from assisting or instructing students and be careful not to block students' view when they need to see the board. Avoid disrupting the teacher, refrain from side conversations, and silence phones. Arrive on time and stay for the entire lesson.
- **Focus on the same small group of students over the entire lesson.** This is likely to yield the best picture of whether and how the students developed understanding. Consider recording students' mathematical thinking and interactions with peers and the instructor.



SCHEDULE PRE-OBSERVATION MEETING

If you will have non-team members at the observation, invite your guests to a pre-observation meeting. During this session your team will distribute copies of the lesson plan, provide time for observers to read the plan, answer questions they may have, bring their attention to the assessment questions to focus their data collection, and review the observation protocol (see observation protocol in the Appendix).



DISCUSS

- What will our team need to do to prepare for the teach and observe?
- What's important to remember about the purpose of the observation?
- What questions do we have about the observation protocol?



OUR TEAM'S CHECKLIST



Team Notebook: Teach and Observe Checklist

6 Teach and Observe the Lesson

After creating a lesson plan that captures your team’s approach, in this step the team gets a chance to see the plan in action. While one team member executes the plan, the others observe and collect evidence that supports or raises questions about the team’s ideas and hypotheses. During lesson study observations, it is important to pay attention to the details: What do you see? What do you hear? Most of all, how do these details help you uncover and understand student thinking? The focus of the observation is on the students – not the instructor – and on what the lesson is designed to help students learn.

Because the lesson plan reflects the collaborative effort and thinking of the team, the instructor should do his or her best to follow it. If the team has carefully anticipated the students’ possible reactions to the lesson and identified instructor responses, changing the lesson during the teaching is usually not appropriate. However, if the teaching situation unfolds in a way that wasn’t predicted, the instructor should feel comfortable deviating from the lesson plan. For example, if student responses suggest that teaching the lesson as written will strengthen student misconceptions that will be difficult to address later, the instructor should make that midcourse correction.

If the lesson plan is changed, you will have a chance to discuss why and whether those changes helped students learn. As Akihiko Takahashi writes, “Planning a lesson for lesson study is not drawing a single path to the goal. It is more like drawing a map around the topic that we teach.”¹

¹ Stepanek, J., Appel, G., Leong, M., Mangan, M. T., & Mitchell, M. (2007). *Leading lesson study: A practical guide for teachers and facilitators* (pp. 94-94). Thousand Oaks, CA: Corwin Press.

7 Debrief and Discuss Observation Data

During the debriefing, team members and observers share observation data, discuss evidence of student learning, and explore the extent to which students met the goals and learning outcomes outlined in the plan. If possible, schedule the debriefing to take place in the same classroom in which the teaching was held. This enables everyone to refer to the whiteboard, posters, or teaching tools used. If this is not possible, the team can take photos of the whiteboard and collect artifacts of student work to reference during the debriefing.

ROLES

Facilitator

Recorder

Process watcher

Timekeeper



FOLLOW THE DEBRIEFING PROTOCOL

Prior to the debriefing, select a facilitator to lead the discussion, a commentator to summarize key ideas, and a recorder to document the discussion. The facilitator begins by acknowledging and celebrating the efforts of the instructor who taught the lesson. The flow of the discussion is outlined in the debriefing protocol (below and in the Appendix). It's important to remember that the discussion should start with concrete observations of student thinking and actions and address the lesson plan's assessment questions and intended learning outcomes before moving to more general topics.

- **Introductions (5 min).** The facilitator expresses appreciation to the instructor for welcoming observers into their classroom and to the team for their work on the lesson. The facilitator briefly restates the team's goals: lesson goals, learning outcomes, and research theme.
- **Instructor's Reflections (5 min).** The instructor shares thoughts about implementing the team's plan that includes both successes and challenges in conducting the lesson. The instructor leads the way, giving everyone permission to genuinely analyze the lesson and to offer perceived difficulties based on the evidence. The instructor's initial observations will set the stage for others to take an analytic but supportive approach to the discussion.
- **Sharing Observational Data (15 min).** Lesson study team members, followed by other observers, present data from the lesson focusing on evidence of student thinking and the questions and evaluation points noted in the lesson plan. Comments should focus on what was seen and heard and avoid subjective statements. In addition to anticipated responses, were there any unanticipated student responses?
- **General Discussion (15 min).** The facilitator invites a more free-flowing discussion among team members and observers. Additional questions can be asked or observations shared; comments already offered can be probed at a deeper level; and ideas for strengthening the lesson can be proposed.
 - To what extent were the goals and learning outcomes met?
 - Which students met these goals?
 - What implications are there for equitable opportunities for learning?

- **Final Commentary (5 min).** If possible, an outside observer should serve as the final commentator. The final commentator contributes any new insights or questions not previously shared in the debriefing, summarizes key ideas and questions that emerged from the debriefing, highlights areas and issues the team might want to pay attention to as they revise the lesson, expresses appreciation to the instructor for opening their classroom to the group, and thanks the team for all of its work.



OUR TEAM'S DEBRIEF SUMMARY



Team Notebook: Debrief 1

After outside observers have left the debriefing, each team member reflects silently for a moment and then shares one success, one challenge, and one question for the team to consider during the revision process.

8 Revise the Lesson

The revising phase of the lesson study cycle is an opportunity for team members to use the data they gathered during the observation and debriefing of the first teaching to make improvements to the lesson and prepare for a second implementation. The team examines how the data provide evidence of the extent to which students have met the goals and learning outcomes of the lesson and revisits the research theme. When instructors use observations and feedback to inform another iteration of the research lesson, they benefit from having more concrete data to inform the development of the revised lesson.

ROLES

Facilitator

Recorder

Process watcher

Timekeeper



DISCUSS AND RECORD AS YOU GO



Lesson Plan 2

Review Debrief 1 Summary

The recorder shares notes from the debrief summary discussion. Next, each team member individually determines and highlights which parts of the lesson support student learning and which parts might be revised to be more effective. The following questions may be helpful:

- What do the analyses of the data on student learning tell us about the impact of our instructional decisions?
- What aspects of the lesson and/or instructional decisions may have contributed to student learning?
- Which aspects of the lesson plan should our team reexamine to increase student learning? How can the research or evidence-based practices help us address these challenges?

Each team member should highlight one or two parts of the lesson to recommend changing.

Identify needed changes

Team members share their recommendations with the rest of the team. Then the facilitator leads the team in identifying common themes across the recommendations and selecting two or three aspects of the lesson to prioritize for revision. If relevant, team members should identify areas or topics that could be strengthened by consulting the research base.

Revise the lesson plan

Using the priorities identified earlier, the team revises the lesson using the following questions as a guide:

- How can we change the lesson plan to help students more effectively reach the learning goals?
- How can the research help us with these changes?

Resave the original lesson plan and create a new file for the revised version of the lesson called Lesson Plan 2. Be sure to keep a copy of the original lesson, as it can be beneficial to indicate how the revised lesson is different from the original lesson.

Review full lesson

After addressing the priorities for revision, the team reviews the entire lesson to determine if any other small adjustments should be made. Avoid making major changes that could shift the focus of the lesson. Teams then make enough copies for all team members and observers to use during the reteaching of the lesson.



OUR TEAM'S REVISED LESSON

Lesson Plan 2

Resave the original lesson plan and create a new file for the revised version of the lesson called Lesson Plan 2.

9 Reteach, Observe, and Debrief

A team member reteaches the lesson to a different group of students while others observe and collect evidence of student learning. The team discusses and reflects on the reteaching results.

ROLES

Facilitator

Recorder

Process watcher

Timekeeper



PREPARE FOR THE RETEACH

- Reserve a room for debriefing
- Send observation and debriefing times and locations to observers
- Make and distribute copies of the lesson plan and any handouts
- Prepare student names tags
- If needed, schedule and convene a pre-observation meeting for non-team members



OBSERVATION PROTOCOL

- **Collect data requested by the lesson planning team.** Be prepared by reading the lesson plan closely prior to the observation. Focus on the “points of evaluation” and questions outlined by the team. Stay present and record observations on the lesson plan handouts.
- **Respect the classroom atmosphere and natural flow of the lesson.** Refrain from assisting or instructing students and be careful not to block students’ view when they need to see the board. Avoid disrupting the teacher, refrain from side conversations, and silence phones. Arrive on time and stay for the entire lesson.
- **Focus on the same small group of students over the entire lesson.** This is likely to yield the best picture of whether and how the students developed understanding. Consider recording students’ mathematical thinking and interactions with peers and the instructor.



SCHEDULE PRE-OBSERVATION MEETING

If you will have non-team members at the observation, invite your guests to a pre-observation meeting. During this session your team will distribute copies of the lesson plan, provide time for observers to read the plan, answer questions they may have, bring their attention to the assessment questions to focus their data collection, and review the observation protocol (see observation protocol in the Appendix).



FOLLOW THE DEBRIEFING PROTOCOL

Prior to the debriefing, select a facilitator to lead the discussion, a commentator to summarize key ideas, and a recorder to document the discussion. The facilitator begins by acknowledging and celebrating the efforts of the instructor who taught the lesson. The flow of the discussion is outlined in the debriefing protocol (below and in the Appendix). It's important to remember that the discussion should start with concrete observations of student thinking and actions and address the lesson plan's assessment questions and intended learning outcomes before moving to more general topics.

- **Introductions (5 min).** The facilitator expresses appreciation to the instructor for welcoming observers into their classroom and to the team for their work on the lesson. The facilitator briefly restates the team's goals: lesson goals, learning outcomes, and research theme.
- **Instructor's Reflections (5 min).** The instructor shares thoughts about implementing the team's plan including both successes and challenges in conducting the lesson. The instructor leads the way, giving everyone permission to genuinely analyze the lesson and to offer perceived difficulties based on the evidence. The instructor's initial observations will set the stage for others to take an analytic but supportive approach to the discussion.
- **Sharing Observational Data (15 min).** Lesson study team members, followed by other observers, present data from the lesson focusing on evidence of student thinking and the questions and evaluation points noted in the lesson plan. Comments should focus on what was seen and heard and avoid subjective statements. In addition to anticipated responses, were there any unanticipated student responses?
- **General Discussion (15 min).** The facilitator invites a more free-flowing discussion among team members and observers. Additional questions can be asked or observations shared; comments already offered can be probed at a deeper level; and ideas for strengthening the lesson can be proposed.
 - How were the observations about student understanding different from the first lesson? What may have been the causes for these differences?
 - Did the changes to the lesson bring about desired changes in student learning?
 - Keeping the goals in mind, did the changes to the lesson result in a more effective lesson?
- **Final Commentary (5 min).** If possible, an outside observer should serve as the final commentator. The final commentator contributes any new insights or questions not previously shared in the debriefing, summarizes key ideas and questions that emerged from the debriefing, highlights evidence-based practices for further investigation, expresses appreciation to the instructor for opening their classroom to the group, and thanks the team for all of its work.



OUR TEAM'S DEBRIEF SUMMARY

Team Notebook: Debrief 2

After outside observers have left the debriefing, the team records its responses to the following questions:

- How were the observations about student understanding different from the first lesson?
What may have been the causes for these differences?
- Did the changes to the lesson bring about the desired changes in student learning?
- Keeping the goals in mind, did the changes result in a more effective lesson?

10 Reflect and Report

The team reflects on the teaching and reteaching results and synthesizes the lessons learned. The team generates a report that can be shared with colleagues or adapted for sharing with a broader audience of educators.

Discuss and record the team's ideas on the following questions on the Final Report template in the Team Notebook. The Debrief 2 Summary, as well as earlier documents and Lesson Plan 1, may be helpful for this step.

ROLES

Facilitator

Recorder

Process watcher

Timekeeper



DISCUSS AND RECORD AS YOU GO



Final Report

Develop and Sustain A Collaborative Team

- In what ways were you and your colleagues successful in collaborating as a lesson study team? If possible, identify specific factors that contributed to your team's success (e.g., discussion items, collaboration norms, or new approaches to any aspect of lesson study).
- Describe how you overcame specific challenges to your cycle.
- Describe any new insights or questions about student learning that resulted from your work with this research theme.

Study Research and Apply Evidence-Based Practices

- How did your team study the research and apply evidence-based practices? Which evidence-based instructional approaches did your team include in the lesson?
- How did your team address and/or strengthen "learning progressions" for this topic (i.e., the sequence of tasks, activities, and lessons that build on prior knowledge)?
- Please identify any research topics you would have liked to explore more deeply (and may wish to explore in future cycles).

Generate and Share Professional Knowledge

- What did your team learn that can be generalized and applied more broadly in your teaching practice? Describe when it might be most useful to use this learning (e.g., which lessons or topics being taught).
- How will you share this learning with others? If possible, propose a specific method for disseminating these learnings.

OUR TEAM'S FINAL REPORT



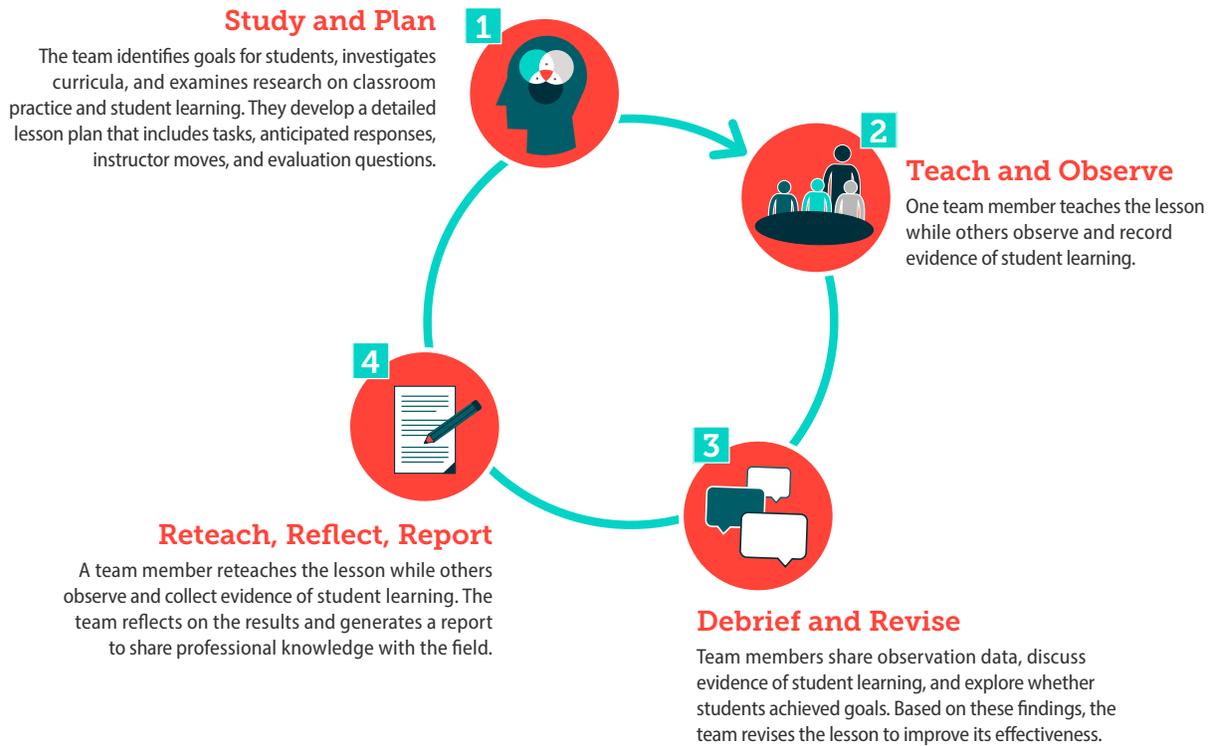
Final Report

Appendix

Lesson Study

Lesson Study is a collaborative professional development approach focused on student learning. The Lesson Study Cycle is comprised of four stages. Typically, teams complete one or two cycles each academic year. Attention to the three Lesson Study Implementation Practices helps teams build capacity to understand student learning and make meaningful changes to their teaching practice.

Lesson Study Cycle



Implementation Practices



DEVELOP AND SUSTAIN A COLLABORATIVE TEAM

- Establish purpose and long-term goals
- Articulate and attend to collaboration norms
- Maintain an inquiry focus on student learning



STUDY RESEARCH AND APPLY EVIDENCE-BASED PRACTICES

- Explore research literature on student development of mathematical understanding
- Investigate evidence-based instructional approaches and practices



GENERATE AND SHARE PROFESSIONAL KNOWLEDGE

- Synthesize and document lessons learned
- Consider broader application for teaching practice
- Share knowledge with the field

Lesson Study: Observation Protocol

Establishing and communicating protocols for observers will clarify their role during the teaching of the team's lesson. Observers will be expected to:

- **Collect data requested by the lesson planning team.** Be prepared by reading the lesson plan closely prior to the observation. Focus on the “points of evaluation” and questions outlined by the team. Stay present and record observations on the lesson plan handouts.
- **Respect the classroom atmosphere and natural flow of the lesson.** Refrain from assisting or instructing students and be careful not to block students' view when they need to see the board. Avoid disrupting the teacher, refrain from side conversations, and silence phones. Arrive on time and stay for the entire lesson.
- **Focus on the same small group of students over the entire lesson.** This is likely to yield the best picture of whether and how the students developed understanding. Consider recording students' mathematical thinking and interactions with peers and the instructor.

Lesson Study: Debriefing Protocol

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- **Introductions (5 min).** The facilitator expresses appreciation to the instructor for welcoming observers into their classroom and to the team for their work on the lesson. The facilitator briefly restates the team's goals: lesson goals, learning outcomes, and research theme.
- **Instructor's Reflections (5 min).** The instructor shares thoughts about implementing the team's plan that includes both successes and challenges in conducting the lesson. The instructor leads the way, giving everyone permission to genuinely analyze the lesson and to offer perceived difficulties based on the evidence. The instructor's initial observations will set the stage for others to take an analytic but supportive approach to the discussion.
- **Sharing Observational Data (15 min).** Lesson study team members, followed by other observers, present data from the lesson focusing on evidence of student thinking and the questions and evaluation points noted in the lesson plan. Comments should focus on what was seen and heard and avoid subjective statements. In addition to anticipated responses, were there any unanticipated student responses?
- **General Discussion (15 min).** The facilitator invites a more free-flowing discussion among team members and observers. Additional questions can be asked or observations shared; comments already offered can be probed at a deeper level; and ideas for strengthening the lesson can be proposed.
 - To what extent were the goals and learning outcomes met?
 - Which students met these goals?
 - What implications are there for equitable opportunities for learning?
- **Final Commentary (5 min).** The final commentator contributes any new insights or questions not previously shared in the debriefing, summarizes key ideas and questions that emerged from the debriefing, highlights areas and issues the team might want to pay attention to as they revise the lesson, expresses appreciation to the instructor for opening their classroom to the group, and thanks the team for all of its work.

Lesson Study: Debriefing Protocol for Reteach

During the debriefing, team members and observers share observation data, discuss evidence of student learning, and explore the extent to which students met the goals and learning outcomes outlined in the plan. It's important to remember that the discussion should start with concrete observations of student thinking and actions and should address the lesson plan's assessment questions and intended learning outcomes before moving to more general topics.

- **Introductions (5 min).** The facilitator expresses appreciation to the instructor for welcoming observers into their classroom and to the team for their work on the lesson. The facilitator briefly restates the team's goals: lesson goals, learning outcomes, and research theme.
- **Instructor's Reflections (5 min).** The instructor shares thoughts about implementing the team's plan that includes both successes and challenges in conducting the lesson. The instructor leads the way, giving everyone permission to genuinely analyze the lesson and to offer perceived difficulties based on the evidence. The instructor's initial observations will set the stage for others to take an analytic but supportive approach to the discussion.
- **Sharing Observational Data (15 min).** Lesson study team members, followed by other observers, present data from the lesson focusing on evidence of student thinking and the questions and evaluation points noted in the lesson plan. Comments should focus on what was seen and heard and avoid subjective statements. In addition to anticipated responses, were there any unanticipated student responses?
- **General Discussion (15 min).** The facilitator invites a more free-flowing discussion among team members and observers. Additional questions can be asked or observations shared; comments already offered can be probed at a deeper level; and ideas for strengthening the lesson can be proposed.
 - How were the observations about student understanding different from the first lesson? What may have been the causes for these differences?
 - Did the changes to the lesson bring about desired changes in student learning?
 - Keeping the goals in mind, did the changes to the lesson result in a more effective lesson?
- **Final Commentary (5 min).** If possible, an outside observer should serve as the final commentator. The final commentator contributes any new insights or questions not previously shared in the debriefing, summarizes key ideas and questions that emerged from the debriefing, highlights evidence-based practices for further investigation, expresses appreciation to the instructor for opening their classroom to the group, and thanks the team for all of its work.

Resources

LESSON STUDY RESOURCES

Designing and adapting tasks in lesson planning: a critical process of lesson study

Toshiakira Fujii

ZDM Mathematics Education (2016)

Retrieved from: <https://link.springer.com/content/pdf/10.1007%2Fs11858-016-0770-3.pdf>

From the abstract: "There is no doubt that a lesson plan is a necessary product of Lesson Study. However, the collaborative work among teachers that goes into creating that lesson plan is largely under-appreciated by non-Japanese adopters of Lesson Study, possibly because the effort involved is invisible to outsiders, with our attention going to its most visible part, the live research lesson. This paper makes visible the process of lesson planning and the role and function of the lesson plan in Lesson Study, based on case studies conducted by Project IMPULS at Tokyo Gakugei University in three Japanese schools. The paper identifies key features of the planning process in Lesson Study, including its focus on task design and the flow of the research lesson, and offers suggestions for educators seeking to improve Lesson Study outside Japan."

Implementing Japanese lesson study in a higher education context

Kadir Demir, Charlene M. Czerniak, and Lynn C. Hart

Journal of Science College Teaching (2013)

Retrieved from: https://s3.amazonaws.com/nstacontent/jcst1304_22.pdf?AWSAccessKeyId=AKIAIMRSQAV7P6X-4QIKQ&Expires=1566481583&Signature=hksHCDejm74NPcLNxnQXAGeYMiQ%3d

From the article: "The purpose of this article is to describe a reform model of instructional collaboration, Japanese lesson study, which has been shown in previous research to enhance reform-based teaching. Japanese lesson study is a method of professional development in which teachers collaborate with peers and other specialists to improve teaching and learning. This paper gives an overview of the need to improve instruction at the college level and a summary of the difficulties of making change in higher education. We discuss how Japanese lesson study can be a practical guide for making improvements in teaching and learning in college settings. We present findings from cases on the basis of our experiences and provide suggestions for implementing high quality lesson study in college science and mathematics courses. Finally, we review the benefits and limitations of the model in the context of higher education."

Learning to lead, leading to learn: How facilitators learn to lead lesson study

Jennifer M. Lewis

ZDM Mathematics Education (2016)

Retrieved from: http://coe.wayne.edu/profiles/zdm_lewis_learning_to_lead.pdf

From the abstract: "This article presents research on how teacher developers in the United States learn to conduct lesson study. Although the practice of lesson study is expanding rapidly in the US, high-quality implementation requires skilled facilitation. In contexts such as the United States where this form of professional development is relatively novel, few teachers have participated in lesson study, so leaders of lesson study groups do not have that prior experience to draw upon for facilitation. To establish lesson study groups, teacher developers are therefore needed in the US context, but we know little about how leaders who are new to lesson study learn to do this work. To investigate this, two novice teacher developers were followed for a period of eighteen months, from their first exposure to the literature on lesson study, through their participation in lesson study conferences, apprenticeship with an experienced lesson study leader, and into their independent conduct of lesson study groups. Data show that the facilitators learned to contend with such issues as teacher resistance, the use of time, and the shifting imperatives of directing teachers' work versus stepping back to give teachers autonomy in determining their collective work. The article concludes by suggesting that lesson study functions as a countercultural bulwark in the field of teacher learning by promoting a participant-driven, time-intensive form of professional development, and that, despite its novelty and complexity, teacher developers with strong mathematical and pedagogical backgrounds become reasonably skillful facilitators in a surprisingly short span of time."

Lesson study as a model for building pedagogical knowledge and improving teaching

William Cerbin and Bryan Kopp

International Journal of Teaching and Learning in Higher Education (2006)

Retrieved from: <http://www.isetl.org/ijtlhe/pdf/IJTLHE110.pdf>

From the article: "This paper proposes a model for building pedagogical knowledge and improving teaching based on the practice of lesson study. In lesson study a small group of instructors jointly designs, teaches, studies and refines a single class lesson called a research lesson. We describe how college teachers can do lesson study in their classrooms. We explore how the practice of lesson study creates multiple pathways for improving teaching and how the knowledge teachers create can help to advance the practice of teaching in their fields."

Teaching versus teachers as a lever for change: comparing a Japanese and a U.S. perspective on improving instruction

James Hiebert and James W. Stigler

Educational Researcher (2017)

Available for purchase from: <https://journals.sagepub.com/doi/pdf/10.3102/0013189X17711899>

From the abstract: “We examine the distinction between teaching and teachers as it relates to instructional improvement. Drawing from work outside of education on improvement systems and from analyzing the Japanese system of lesson study, we contend that a focus on teaching can shape a coordinated system for improvement whereas a focus on teachers, common in the United States, leads to elements that are uncoordinated and often work against the continuous, steady improvement of classroom teaching. We propose that the concept of systems for improvement and its instantiation in Japanese K–8 education offer opportunities to reexamine U.S. efforts to improve teaching and shift these efforts toward a more promising direction.”

MATHEMATICS AND QUANTITATIVE LITERACY RESOURCES

Helping students become quantitatively literate

Katrina Piatek-Jimenez, Tibor Marcinek, Christine M. Phelps, and Ana Dias

Mathematics Teacher (2012)

Available for purchase from: <https://www.nctm.org/Publications/mathematics-teacher/2012/Vol105/Issue9/Helping-Students-Become-Quantitatively-Literate/>

From the article: “In recent years, the term quantitative literacy has become a buzzword in the mathematics community. But what does it mean, and is it something that we should incorporate into the high school mathematics classroom? We will define quantitative literacy (QL), discuss how teaching for QL differs from teaching a traditional mathematics course, and provide sources of good QL problems that can be incorporated into the middle school, high school, or college curriculum.”

How does lesson study improve mathematics instruction?

Catherine Lewis

ZDM Mathematics Education (2016)

Available for purchase from: <https://link.springer.com/article/10.1007%2Fs11858-016-0792-x>

From the abstract: “This article presents a theoretical model of lesson study’s impact on instruction, through intervening impact on teachers’ knowledge, beliefs and dispositions, teachers’ learning community, and curriculum. It also describes four different types of lesson study in Japan, pointing out their synergies in producing a system where local teachers “demand” knowledge for their lesson study work and lesson study provides a collaborative, practice-based venue to try out recent innovations in curriculum and instruction. Description of lesson study in Japan provides background for considering the articles of this issue, which highlight four strategies to develop lesson study outside Japan: (1) incorporation of high-quality tasks and materials; (2) attention to processes that illuminate student thinking; (3) attention to system features; and (4) models for scale-up.”

Quantitative literacy and civic virtue

William Briggs

Numeracy (2018)

Retrieved from: <https://scholarcommons.usf.edu/cgi/viewcontent.cgi?article=1285&context=numeracy>

From the abstract: "Mathematics educators are occasionally called upon to justify the existence or the offering of quantitative literacy courses. This paper argues that effective quantitative literacy courses have different goals than algebra courses and are legitimate alternatives to algebra courses for non-STEM students. Furthermore, quantitative literacy courses affirm the historic relationship between citizenship and education. In today's world of proliferating news sources, social media, and fake news, quantitative literacy has become an essential component of the long-held ideal of civic virtue."

Teaching the conceptual structure of mathematics

Lindsey E. Richland, James W. Stigler and Keith J. Holyoak

Educational Psychologist (2012)

Retrieved from: http://reasoninglab.psych.ucla.edu/KH%20pdfs/Richland_etal.2012.pdf

From the abstract: "Many students graduate from K–12 mathematics programs without flexible, conceptual mathematics knowledge. This article reviews psychological and educational research to propose that refining K–12 classroom instruction such that students draw connections through relational comparisons may enhance their long-term ability to transfer and engage with mathematics as a meaningful system. We begin by examining the mathematical knowledge of students in one community college, reviewing results that show even after completing a K–12 required mathematics sequence, these students were unlikely to flexibly reason about mathematics. Rather than drawing relationships between presented problems or inferences about the representations, students preferred to attempt previously memorized (often incorrect) procedures (Givvin, Stigler, & Thompson, 2011; Stigler, Givvin, & Thompson, 2010). We next describe the relations between the cognition of flexible, comparative reasoning and experimentally derived strategies for supporting students' ability to make these connections. A cross-cultural study found that U.S. teachers currently use these strategies much less frequently than their international counterparts (Hiebert et al., 2003; Richland, Zur, & Holyoak, 2007), suggesting that these practices may be correlated with high student performance. Finally, we articulate a research agenda for improving and studying pedagogical practices for fostering students' relational thinking about mathematics."

“You’ve got to learn the rules”: A classroom-level look at low pass rates in developmental math

Rebecca D. Cox

Community College Review (2015)

Available for purchase from: <https://journals.sagepub.com/doi/abs/10.1177/0091552115576566>

From the abstract: “Objective: Given the current concern across the United States with improving community-college student outcomes, particularly in developmental education, understanding what students encounter inside developmental education classrooms is a necessary first step. Method: Drawing on data from a study of teaching practices inside developmental math courses at two large, urban-serving community colleges in the Northeast United States, I open up the “black box” of developmental math teaching at the community college level. Focusing specifically on data gathered through classroom observations, instructor interviews, and curricular artifacts from six sections of developmental math, I explore two distinct curricula as they were enacted in class sessions and through the classroom discourse around solving math problems and analyze the extent to which each approach reflects the recommendations for mathematics instruction advocated by professional mathematics associations. Results: I found that differences in pedagogical goals (and related notions of mathematical proficiency) were integrally linked to differences in the what and how of assessing student learning, and that contrasting approaches to assessment maintain critical implications for accounting for failure inside developmental math classrooms. Contributions: I conclude with insights regarding future research and reform, for developmental math instruction both to realize robust mathematical learning goals and to facilitate students’ successful completion of developmental math courses.”