

Mathematics Improvement Network



Lesson Study for Professional Development

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8 Characteristics of effective PD

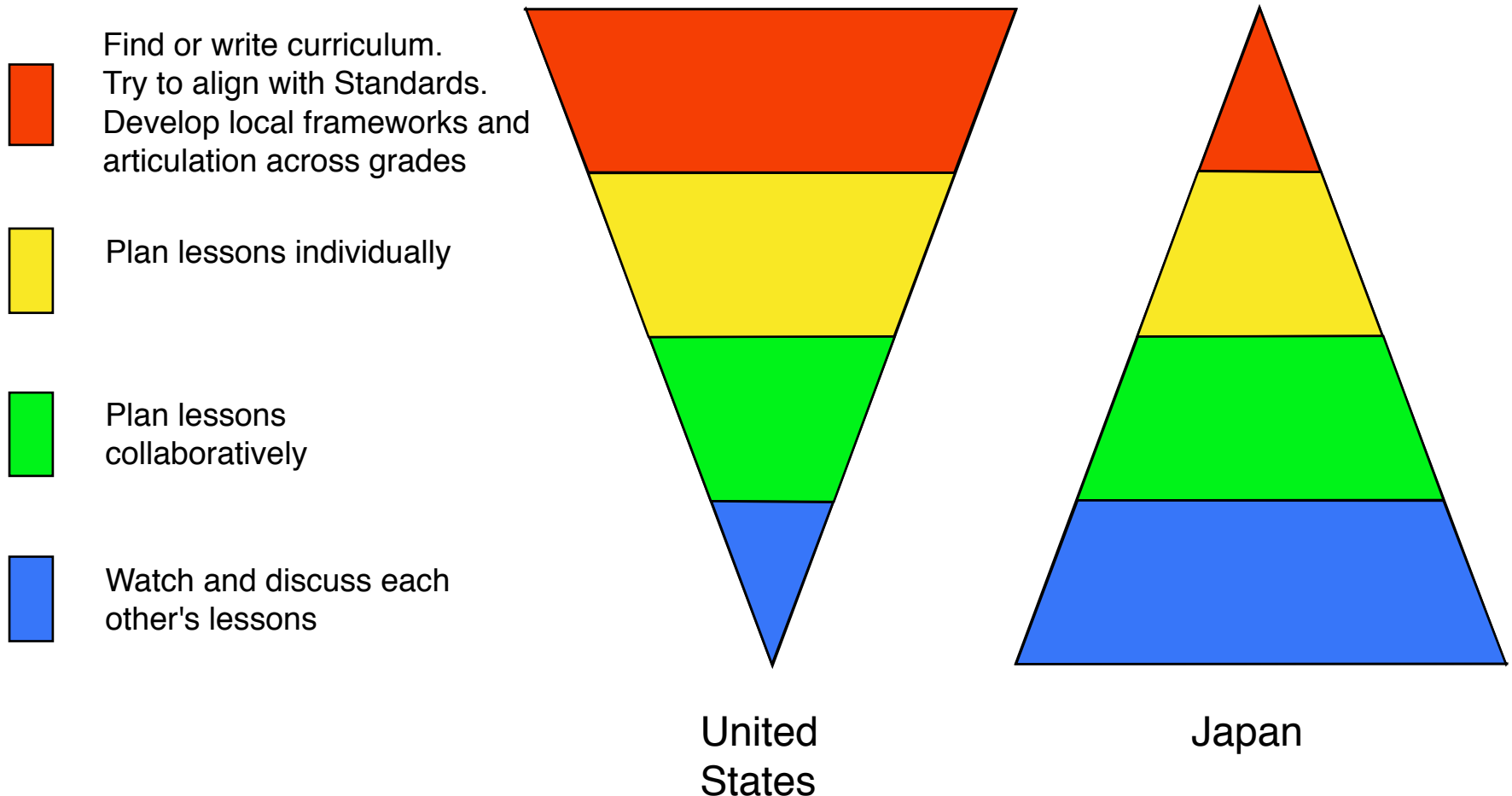
- **Experiential:** stimulating & drawing on teachers' experiences.
- **Sustained:** cycles of planning, predicting, enactment & reflection.
- **Grounded:** practical, well-resourced; related to context & culture.
- **Safe:** teachers able to speak their minds, permission to take risks.
- **Collaborative:** involving networks of teachers & administrators.
- **Informed:** by outside expertise and research.
- **Provocative:** involving both pressure and support.
- **Focused:** attentive to the development of the mathematics itself.

*(Guskey, 2002; Joubert and Sutherland, 2009; Villegas-Reimers, 2003;
and many others...)*

Different forms of PD

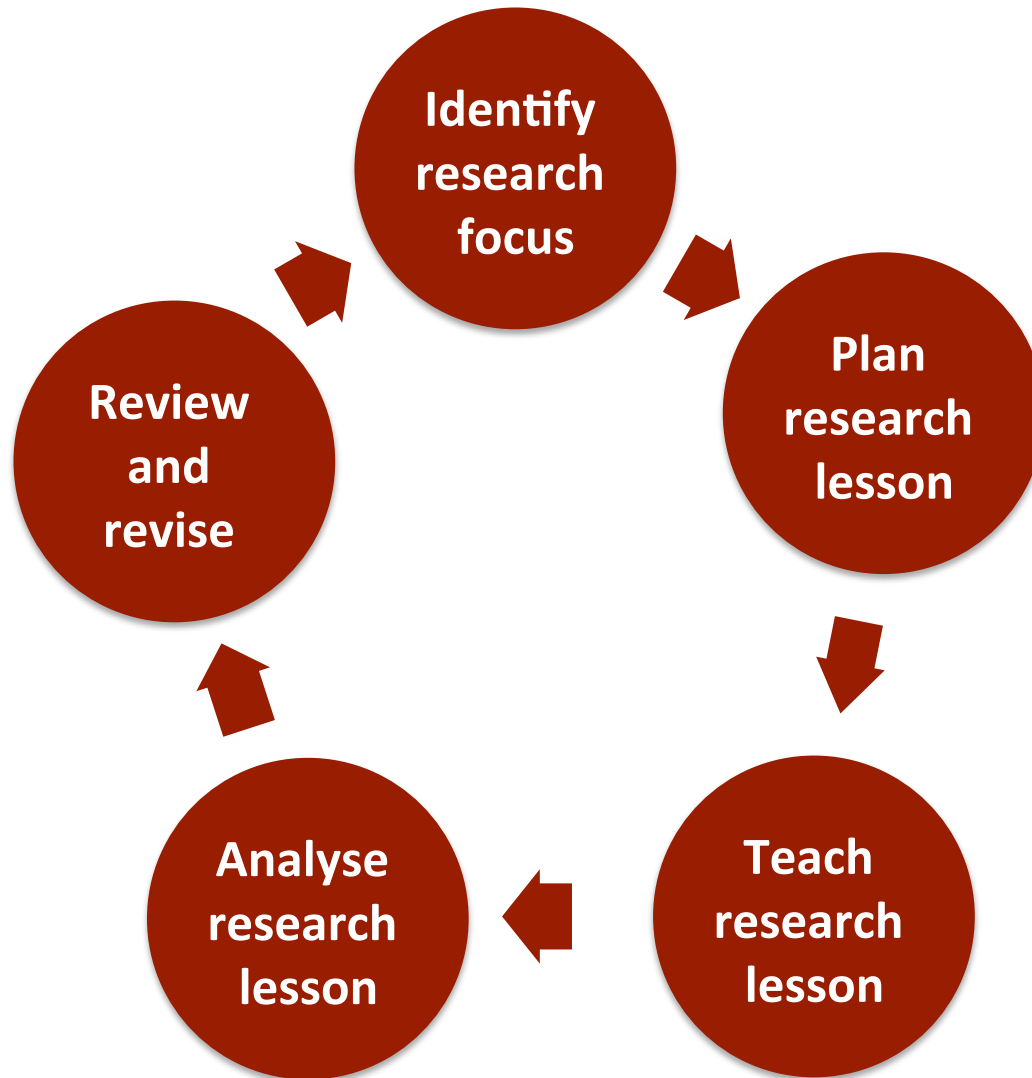
- **“Training” models**
 - Transmission of information and ‘answers’ by an ‘expert’. Useful mainly for raising awareness of an initiative, but may feel alien to teachers.
- **“Experiential course” models**
 - Courses mediated by a provider, that offer teachers opportunities to explore ideas in their own classrooms and report back. May be accredited.
- **“Embedded” professional development communities**
 - Driven by questions. Teachers take responsibility for setting their own research goals and collaboratively and systematically study them in their own classrooms. This may be informed by outside support from materials and/or invited ‘experts’.

Teachers' activities to Improve Instruction

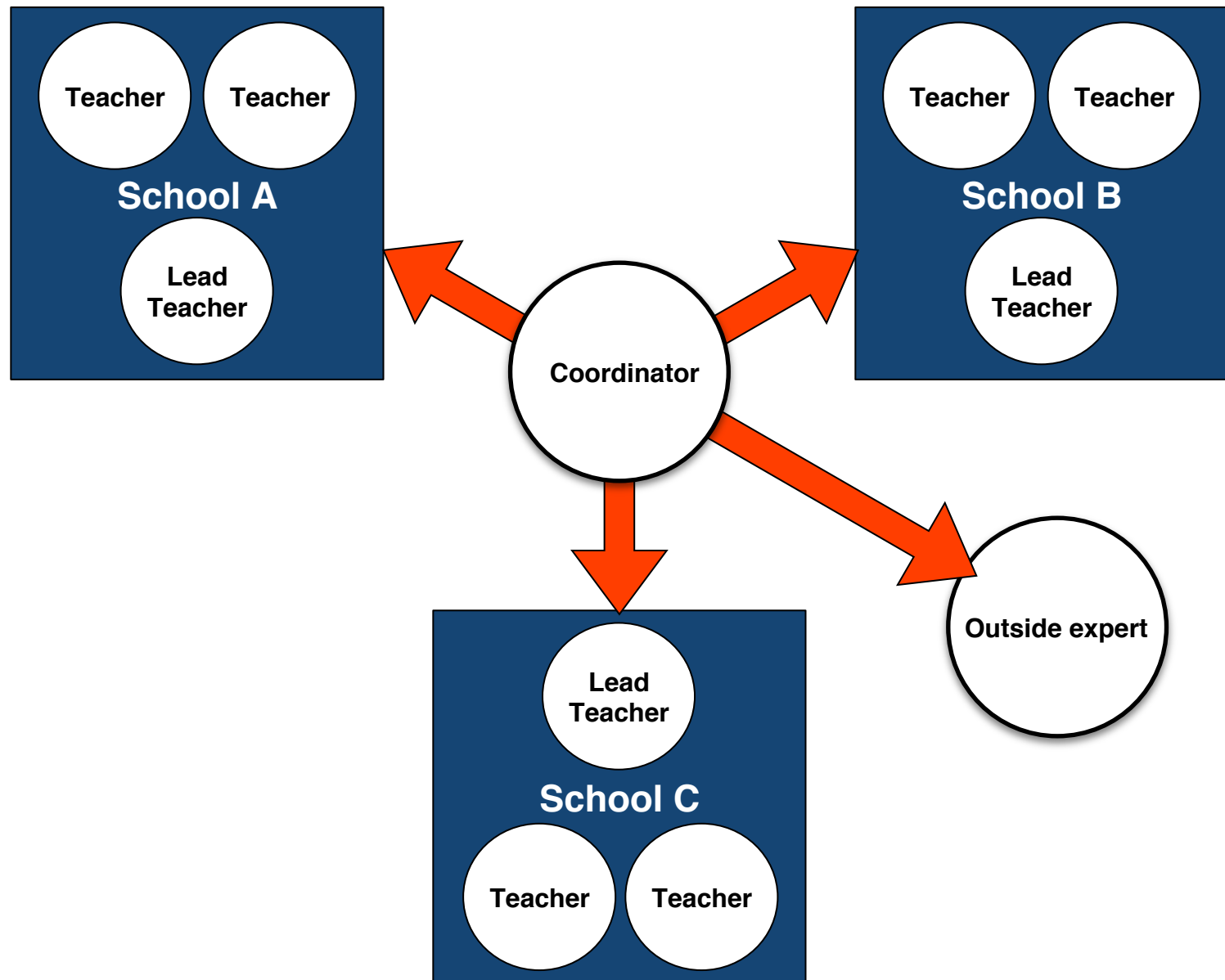


From Lewis, C.; and Hurd, J. (2011), *Lesson Study Step by Step*, Heinemann

Japanese Lesson Study Model



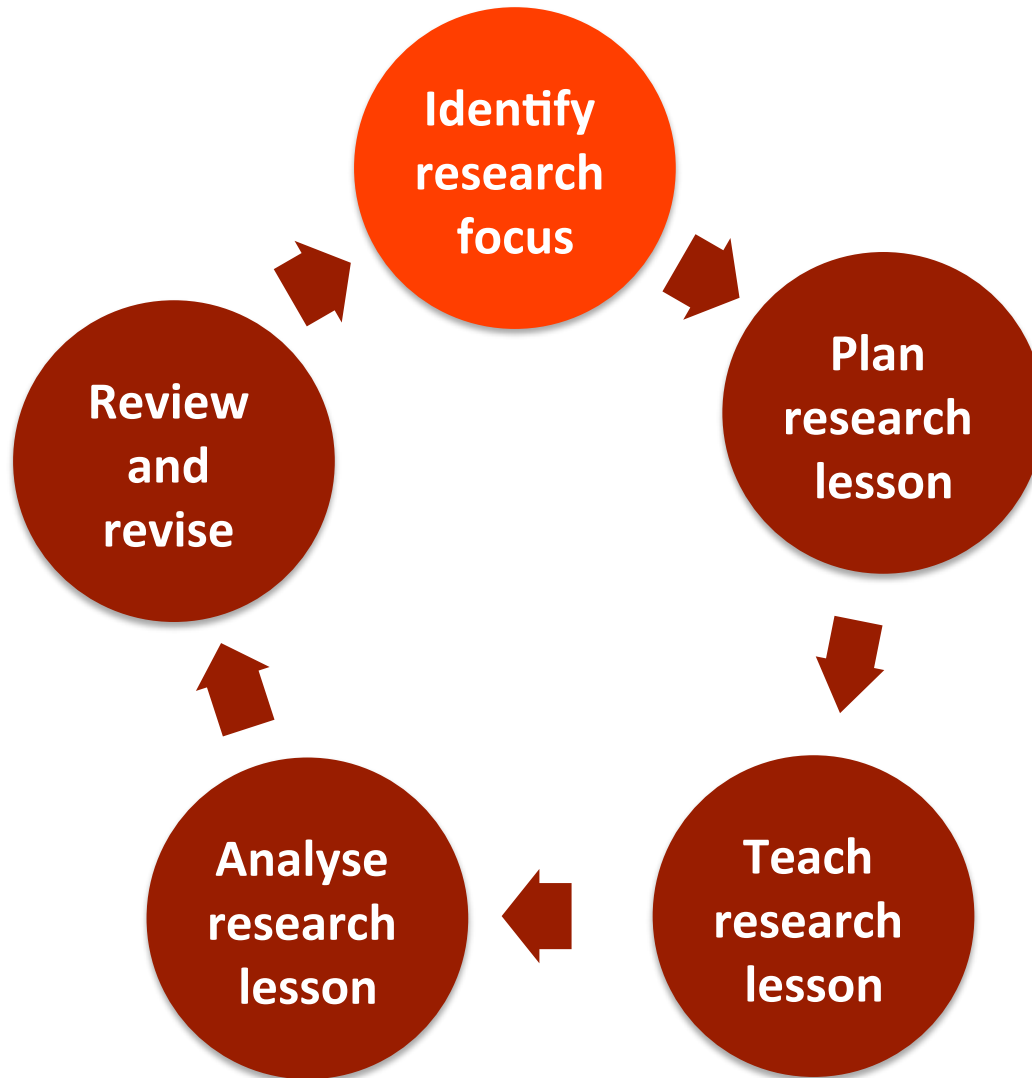
A professional learning community



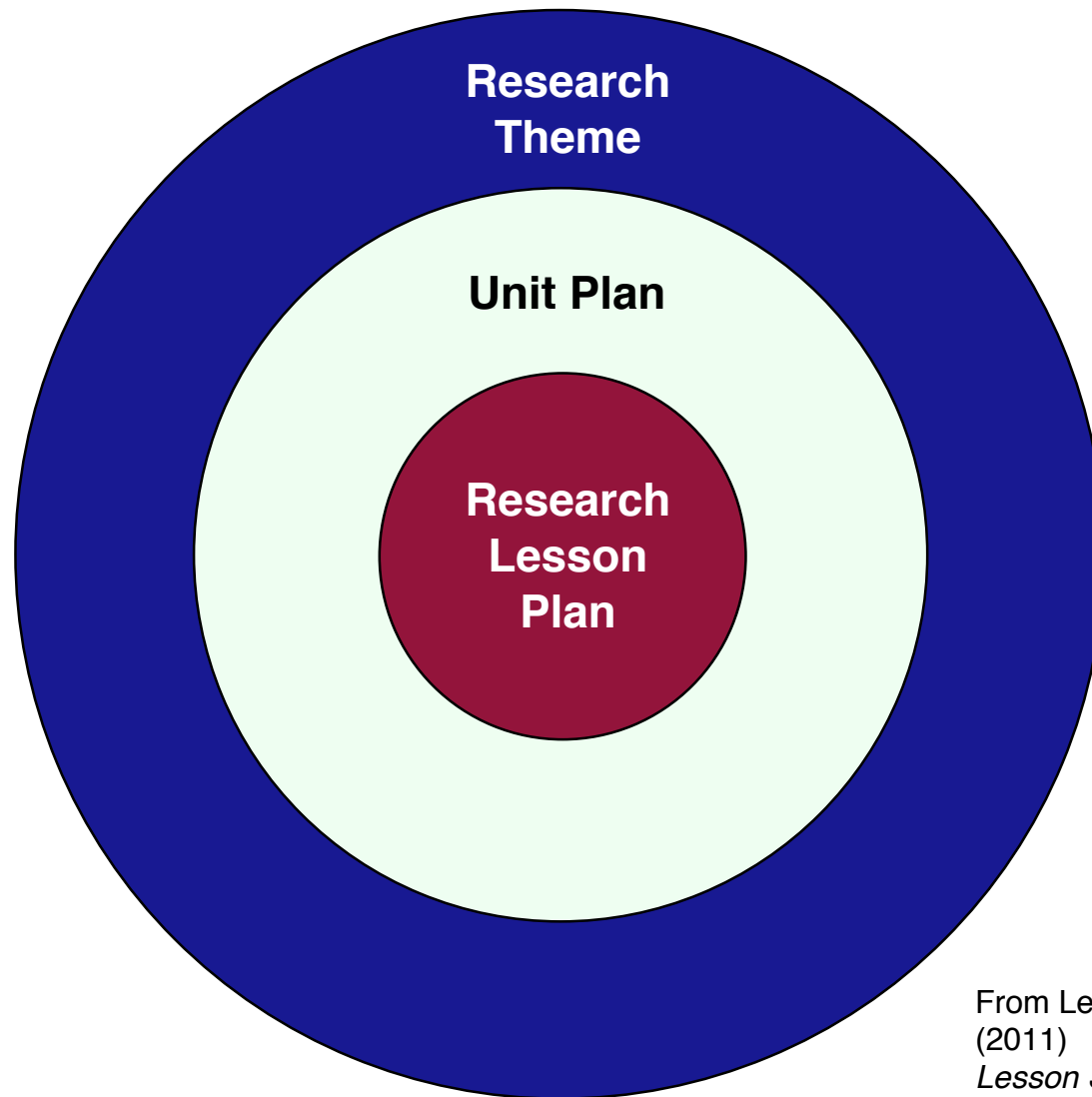
Roles and responsibilities

- **Planning research lessons.**
 - Each school in the cluster is responsible for planning three research lessons spread over the year. These lessons are planned by the teachers in the school, working in consultation with the outside expert.
- **Teaching research lessons.**
 - One teacher from the planning team is responsible for teaching the lesson. Each teacher will therefore teach at most one research lesson per year.
- **Observing and analysing research lessons.**
 - Each teacher will be invited to observe up to eight other research lessons per year. These will all be attended by the outside expert.
- **Revising research lessons.**
 - This is the responsibility of the planning team within each school.

Japanese Lesson Study Model



Establishing a research focus



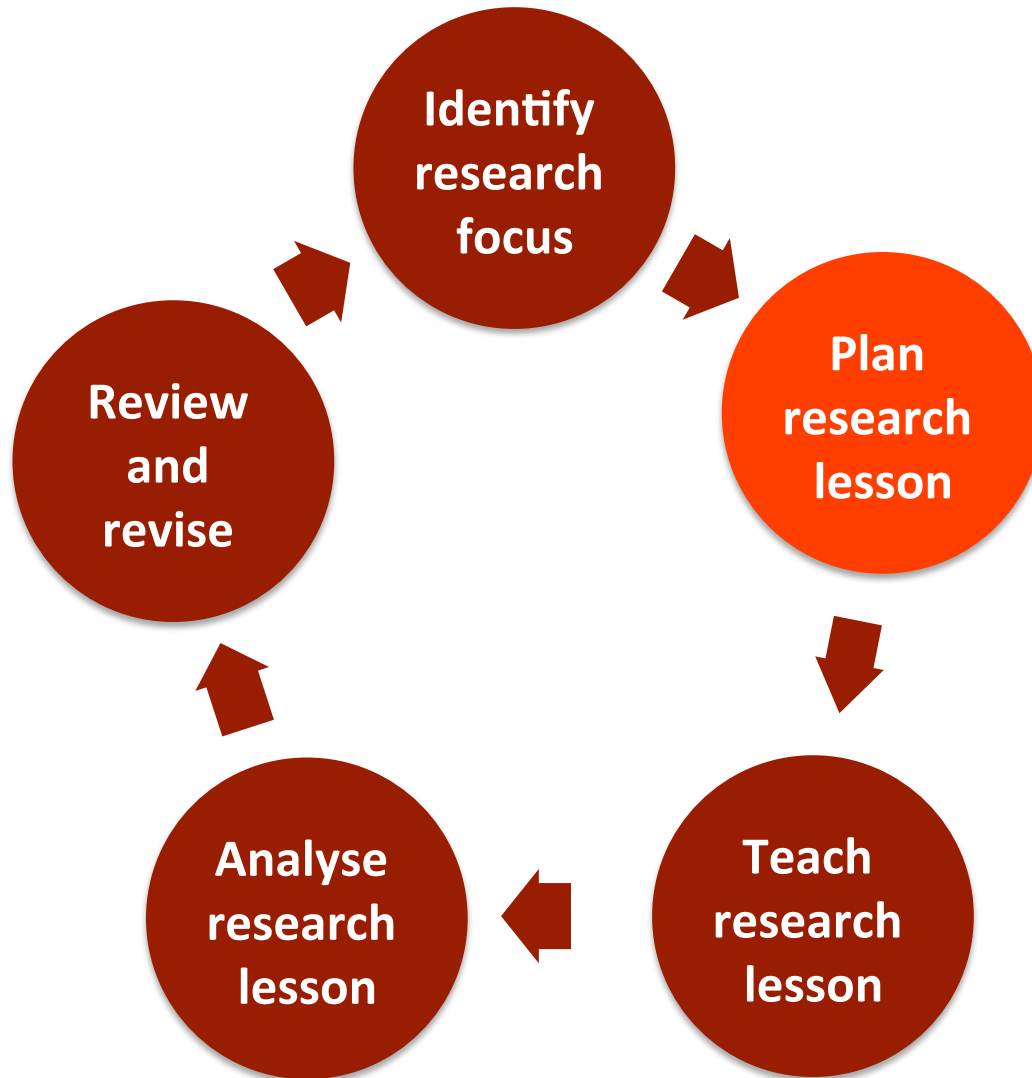
From Lewis, C and Hurd, J,
(2011)
Lesson Study Step-by-Step
Heinemann

Identify the research focus

How might we help students to:

- select powerful representations?
- make sensible assumptions and analyse their effect?
- Identify the variables and relationships in situations?
- become more systematic?
- **plan approaches before embarking on them?**
- **monitor their own approaches more effectively?**
- compare the effectiveness of different approaches, including those used by other students?
- communicate their reasoning more effectively?

Japanese Lesson Study Model

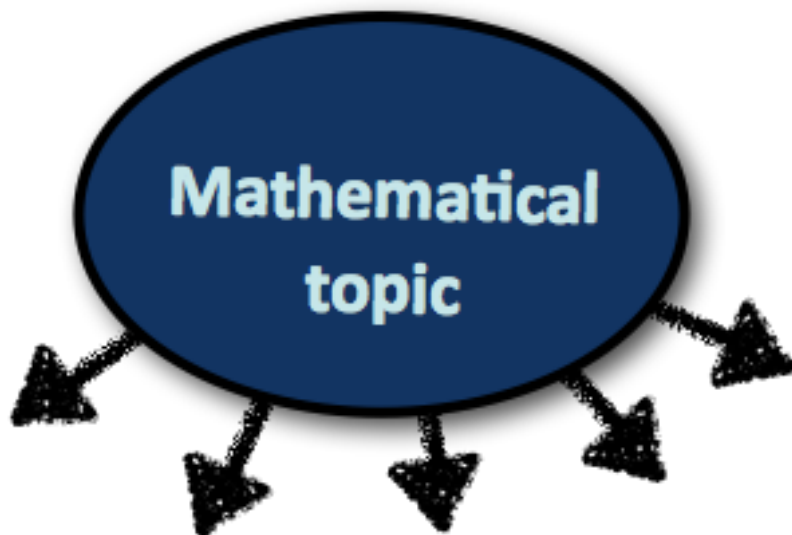


Teachers, collaboratively, plan:

- The task to be used
- The phases within the lesson and their purpose
- The key questions that will be posed
- The needs of particular students
- Anticipated student responses
- Responses to students' responses
- How 'success' may be recognised

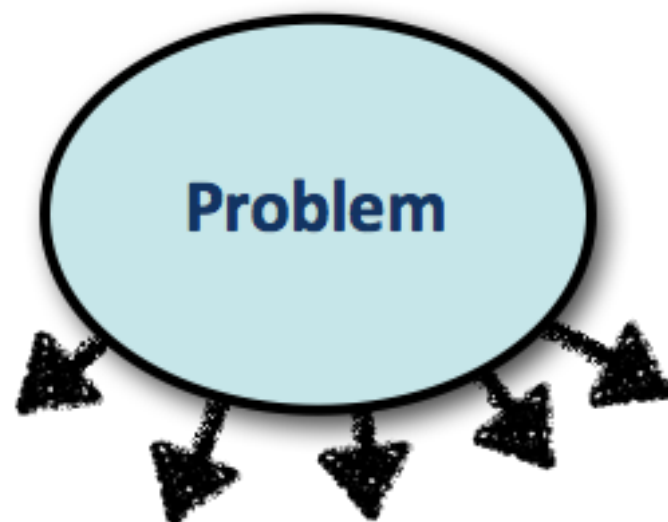
What will be the focus?

**Concept
focused**



**Illustrative
Applications**

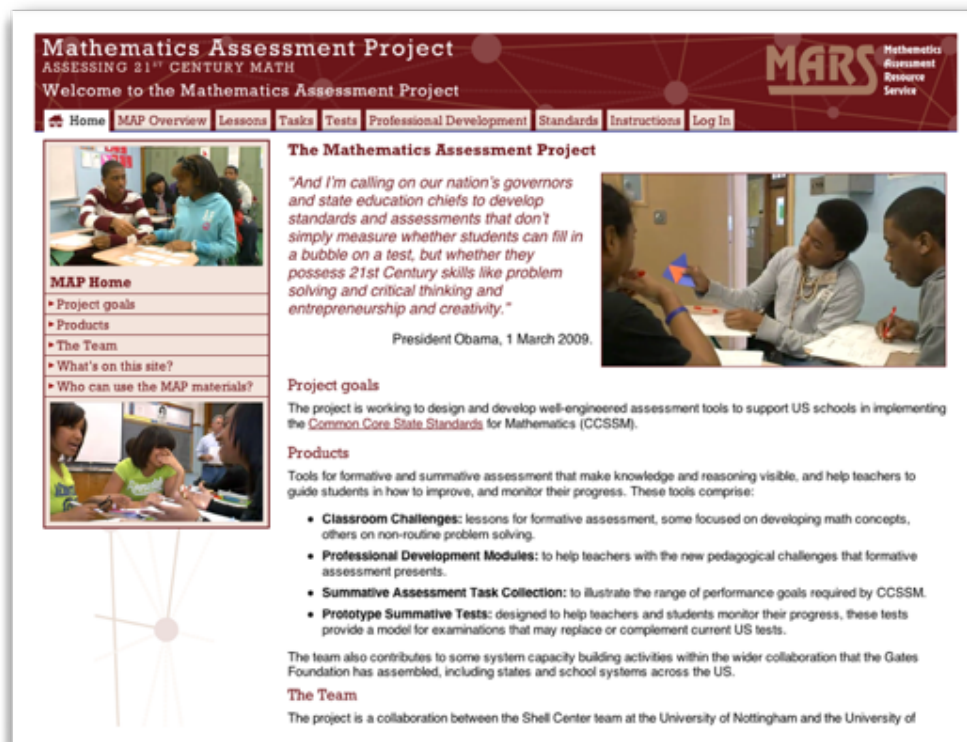
**Problem solving
focused**



**Choose appropriate
mathematical tools**

Mathematics Assessment Project

- 100 “formative assessment” lesson plans
- Two-thirds on concept development
- One third on problem solving.



The screenshot shows the homepage of the Mathematics Assessment Project (MAP). The header features the project name and a navigation bar with links: Home, MAP Overview, Lessons, Tasks, Tests, Professional Development, Standards, Instructions, and Log In. The main content area is divided into several sections. On the left, there is a 'MAP Home' sidebar with links to Project goals, Products, The Team, What's on this site?, and Who can use the MAP materials?. The central part of the page features a quote from President Obama dated March 1, 2009, about the importance of developing standards and assessments that measure 21st-century skills. Below the quote, there is a section titled 'Project goals' which states the project's aim to support US schools in implementing the Common Core State Standards for Mathematics (CCSSM). This is followed by a 'Products' section listing Classroom Challenges, Professional Development Modules, Summative Assessment Task Collection, and Prototype Summative Tests. The page also includes a 'The Team' section mentioning the collaboration between the Shell Center team at the University of Nottingham and the University of... The website design uses a dark red header and a light beige background with a subtle geometric pattern.

Mathematics Assessment Project
ASSESSING 21ST CENTURY MATH
Welcome to the Mathematics Assessment Project

Home MAP Overview Lessons Tasks Tests Professional Development Standards Instructions Log In

MAP Home

- Project goals
- Products
- The Team
- What's on this site?
- Who can use the MAP materials?

The Mathematics Assessment Project

"And I'm calling on our nation's governors and state education chiefs to develop standards and assessments that don't simply measure whether students can fill in a bubble on a test, but whether they possess 21st Century skills like problem solving and critical thinking and entrepreneurship and creativity."

President Obama, 1 March 2009.

Project goals

The project is working to design and develop well-engineered assessment tools to support US schools in implementing the Common Core State Standards for Mathematics (CCSSM).

Products

Tools for formative and summative assessment that make knowledge and reasoning visible, and help teachers to guide students in how to improve, and monitor their progress. These tools comprise:

- **Classroom Challenges:** lessons for formative assessment, some focused on developing math concepts, others on non-routine problem solving.
- **Professional Development Modules:** to help teachers with the new pedagogical challenges that formative assessment presents.
- **Summative Assessment Task Collection:** to illustrate the range of performance goals required by CCSSM.
- **Prototype Summative Tests:** designed to help teachers and students monitor their progress, these tests provide a model for examinations that may replace or complement current US tests.

The team also contributes to some system capacity building activities within the wider collaboration that the Gates Foundation has assembled, including states and school systems across the US.

The Team

The project is a collaboration between the Shell Center team at the University of Nottingham and the University of

map.mathshell.org/materials/

Phases of the lesson

Presentation (Hatsumon)

- Teacher presents the problem
- Students discuss the problem

Developing a solution (Kikan-shido)

- Students develop ideas individually
- Students share ideas
- Teacher observes students, makes notes for later

Comparing strategies (Neriage)

- Students share their solution ideas with whole class
- Students critique solutions, identifying strong and weak points.

Summarising and reflecting (Matome)

- Teacher summarises group findings, identifies important ideas, generalises
- Students summarise what they have learned themselves



Neriage

“Japanese word for the whole class discussion phase of structured problem solving.

It is the core of teaching through problem solving.

This happens after students have shared various solution strategies.

During this phase, students, carefully guided by the teacher, critically analyze, compare and contrast the shared ideas.

They will consider issues like efficiency, generalizability, and similarity to previously learned ideas.”

(Akihiko Takahashi)



Ben Kajitani (Japanese, born 1941),
Untitled #6 (Neriage Vessel), 2000
<https://www.flickr.com/photos/38315261@N00/15233602297>

Outbreak

**A disease has started to spread around the city.
If you get the disease you only have hours to live.**

**Our city has been put under quarantine; no one in or out.
The good news is you are able to help.**

**The scientists from the Research and Development Department
have worked flat out and have managed to put together two
vaccinations.**



Outbreak

- **Vaccination A is 100% effective and costs £12.00 per vaccine.**
- **Vaccination B is 70% effective and costs £5.20 per vaccine.**
- **We have a budget of £5,000,000**

Your task is to recommend:

- **How many of each vaccine should we make?**
- **Who will get those vaccines?**



Occupation	Number in population
Medical workers (doctors, nurses)	75600
Key service workers (electricity, refuse)	113000
Food shop personnel	113000
Farmers and food producers	85100
Other shop workers	104000
Other professionals.... teachers, lawyers, etc.	123000
Other trades people: decorators, plumbers, mechanics, etc.	85100
Retired people	86400
Students and school students	94600
Children under 5	66200
Total	946000

Research lesson – lesson plan

Handout 2: Outbreak! – Lesson Plan

Target Class

Year 9. This will only be the second lesson that the teacher has worked with the class of high ability students. It is envisaged that the research lesson will be the second in a series of either three or four lessons. It is likely that this lesson and some of the next lesson will be focused around the strategic planning and then the rest of the third (and maybe a forth) will be spent writing their reports to the "mayor" and presenting a sample of these to the class.

Research Focus

The research question for this lesson is:

How can we enable students to plan strategically and monitor their approaches more effectively?

The research question, applied to the processes involved in the lesson:

- **Formulating the problem:**
Students need to select the data that is most relevant, then organise a strategic approach. For example, it is better to address the total vaccines available *before* deciding who receives them, rather than allocating them, then finding you have exceeded the budget.
- **Analyzing and solving**
As they work on the problem, students need to monitor their approach and ask themselves monitoring questions such as: "Is this still within the budget?" "Will I have sufficient vaccine?"
- **Communicating, interpreting and evaluating:**
Students will communicate their own solutions and interpret and critique the planning of others.

Introduction

The aim of this lesson is to encourage students to begin to plan the most effective strategy in order to solve the problem. At certain points throughout the lesson the teacher will attempt to encourage students to really think about solving the problem and ensure they do not get lost in the moment with what they are doing. These points in the lesson plan have been underlined to make them clear to the reader.

In the previous lesson they will have had approximately 15 minutes to give an initial response to the "strategic planning" problem (included later in this document). During the research lesson, students will begin to question their initial attempts at the task and then work collaboratively in planning and then carrying out some of the plan they have come up with.

Resources needed

- The task "Outbreak!"
- Webpage with all the video to remind the students of the context
- Large sheets of paper, pens or pencils, calculators
- Individual Whiteboards, pens and rubbers (optional)

Time needed

Approximately 1 hour

Participant materials

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Anticipated
issues table

Progression
grid

Before the lesson

On the students will have been exposed to the context and will be aware of the solve. Students will have been allowed approximately 15 minutes prior to this lesson to sit solution to the problem; this will inform plans to the content of the research lesson, such as where the students will sit. The responses individuals make will also allow the question in written form, to address any misconceptions or further points that need

With the pre-lesson task

Key issues	Suggested questions and prompts
Calculations before planning an the top of the list and calculate the workers, then move to next row	<ul style="list-style-type: none">• Describe in words a plan for tackling this problem.• What are the key decisions you have to make?• Which information are you going to focus on at the start, which will you ignore?
More constraints. that they only have £5 million need 54000 vaccines.	<ul style="list-style-type: none">• Do you have enough resources for your solution?• Have you made enough vaccine for everyone?• Have you wasted any money?• Have you wasted any vaccine?
Decisions made. solution with no explanation.	<ul style="list-style-type: none">• Why have you chosen to allocate the vaccines in this way?• How can you be sure this is the best solution?
Students assume that only vaccine A should effective; or only vaccine B should best.	<ul style="list-style-type: none">• Have you taken all the issues into account?• Could you vaccinate more people if you used some of vaccine B?• Could you save more lives if you used more of vaccine A?
Did the concept of a budget is a good solution will be a cheap need to spend all of the budget	<ul style="list-style-type: none">• What is your main objective when trying to solve the problem?• Are there any more lives that you could possibly save?
Used by the large numbers £4.8 million of the budget, they enough to their maximum and not 1000 you could save many more	<ul style="list-style-type: none">• How much money do you have remaining in your budget?• How many more vaccines would you be able to purchase with this amount of money?
Meaning of their calculations if perform a sensible calculation their answer represents?	<ul style="list-style-type: none">• What does this figure represent? Is it how much money is left over or how much money has been spent? Does it represent an amount of people?
Numbers with no justifications	<ul style="list-style-type: none">• Where have these figures come from? Do you know what they represent? Are you able to justify why you have used these numbers?
Testing the effectiveness of each if not be able to grasp the solve.	<ul style="list-style-type: none">• If 1000 people using vaccination B, how many

representing money on people
For example, students might
the solution 12500, but the
money.

Participant materials

Grid

Strategic Planning	Monitoring work
<ul style="list-style-type: none">• Attempts to work towards a solution by carrying out operations with figures but shows little strategic awareness that will lead to a solution• <u>Can you write down an action plan as to how you are going to complete the task effectively? What are the other pieces of information you need to consider?</u>• Carries out appropriate and correct calculations but does not take constraints into account.• <u>Are there other pieces of information you have not thought about?</u>• Works towards a solution logically reaching a viable solution• <u>Can you think of an alternative approach to solving this problem? What be the effect on the outcome?</u>• Arrives at a solution having considered alternatives.	<ul style="list-style-type: none">• Carries out own calculations without ever stopping to reflect or think about what is being achieved.• Does not stop to consider alternative approaches.• <u>When you have finished this calculation, what will you do next?</u>• <u>What will your answer tell you?</u>• <u>How could you organise your work</u>• Briefly considers alternative approaches by comparing own method with others, but this has little or no impact on own approach. Continues to pursue an inefficient line of reasoning.• <u>Look carefully at your partner's work / this piece of work that I have supplied.</u>• <u>What ideas does it contain that could help your own work?</u>• Stops occasionally and considers the work of others carefully. Compares this use of the approach and tries to make use of the approach.• Finds it difficult to discriminate efficient/ inefficient approaches to the problem, however.• <u>Which of these two ideas is more powerful?</u>• <u>Why is this?</u>• <u>Which of these approaches could still work if we changed the numbers in the problem?</u>• Works with the work of

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P-7

Anticipating student responses

- In a preliminary lesson, the class attempt the task individually in silence.
- Responses are collected and analysed according to the approaches taken.
- Teachers prepare formative feedback questions for students.

Anticipated issues

Students:

- started with detailed calculations before planning:
- ignored constraints.
- did not justify the decisions they made.
- jumped to conclusions:
- didn't understand the concept of a budget
- Were overwhelmed by the large numbers
- didn't grasp meaning of calculations
- didn't understand “effectiveness” of each vaccination:
- became confused between numbers representing money and people.

Key Issue	Suggested questions or prompts
Students start detailed calculations before planning an approach	<ul style="list-style-type: none"> • Describe in words a plan for tackling this problem. • What are the key decisions you have to make? • Which information are you going to focus on at the start, which will you ignore?
Students ignore one or more constraints.	<ul style="list-style-type: none"> • Do you have enough resources for your solution? • Have you made enough vaccine for everyone? • Have you wasted any money? • Have you wasted any vaccine?
Students do not justify decisions made.	<ul style="list-style-type: none"> • Why have you chosen to allocate the vaccines in this way? • How can you be sure this is the best solution?
Students leap to conclusions	<ul style="list-style-type: none"> • Have you taken all the issues into account? • Could you vaccinate more people if you used some of vaccine B? • Could you save more lives if you used more of vaccine A?

	Strategic planning	Monitoring work
Little progress	Carries out operations with figures but shows little strategic awareness that will lead to a solution.	Carries out calculations without stopping to reflect or think about what is being achieved or alternative approaches.
Questions	<i>Can you write a plan for completing the task? What other information must you consider?</i>	<i>When you have finished this calculation, what will you do next? How will you organise your work?</i>
Some progress	Carries out appropriate and correct calculations but does not take constraints into account.	Considers alternative approaches by comparing own method with others, but this has no impact on own approach.
Questions	<i>Are there other pieces of information you have not thought about?</i>	<i>What ideas does your partner's work contain that may help?</i>
Substantial progress	Works towards a solution logically reaching a viable solution	Considers the work of others. Compares approaches and uses them. Finds it difficult to discriminate efficient/inefficient approaches.
Questions	<i>Can you think of another method? What be the effect on the outcome?</i>	<i>Which idea is more powerful? Which method would work with different numbers?</i>
Task accomplished	Arrives at a solution having considered alternatives.	Engages thoughtfully with the work of others. Selects and uses powerful approaches.

Lesson Plan

- Seating plan changes
- Re-introducing the lesson
- Looking at partner's work (Green sheet)
- Collaboration in pairs for a new approach
- Whole class discussion
- Redrafting their approaches
- Summarizing and reflecting

Green sheet to encourage monitoring

Analysing Partner's work

1. Describe briefly what your partner has done.
2. Why do you think they have done this?
3. How is this different from your approach?
4. What impact will this have on your next attempt at the problem?

Using Sample Student Work

Medical workers are the most important
they all get (A)

$$75600 \times 12 = 907200$$

$$\cancel{12} \quad 5000000 - 907200 = \boxed{\begin{array}{r} 4092800 \\ \text{Remaining budget} \end{array}}$$

Farmers and Students are important for the future,
they all get (A)

$$(94600 + 85100) \times 12 = 2156400$$

$$4092800 - 2156400 = \boxed{\begin{array}{r} 1936400 \end{array}}$$

Using Sample Student Work

All get (A) $946000 \times 12 = 11352000$

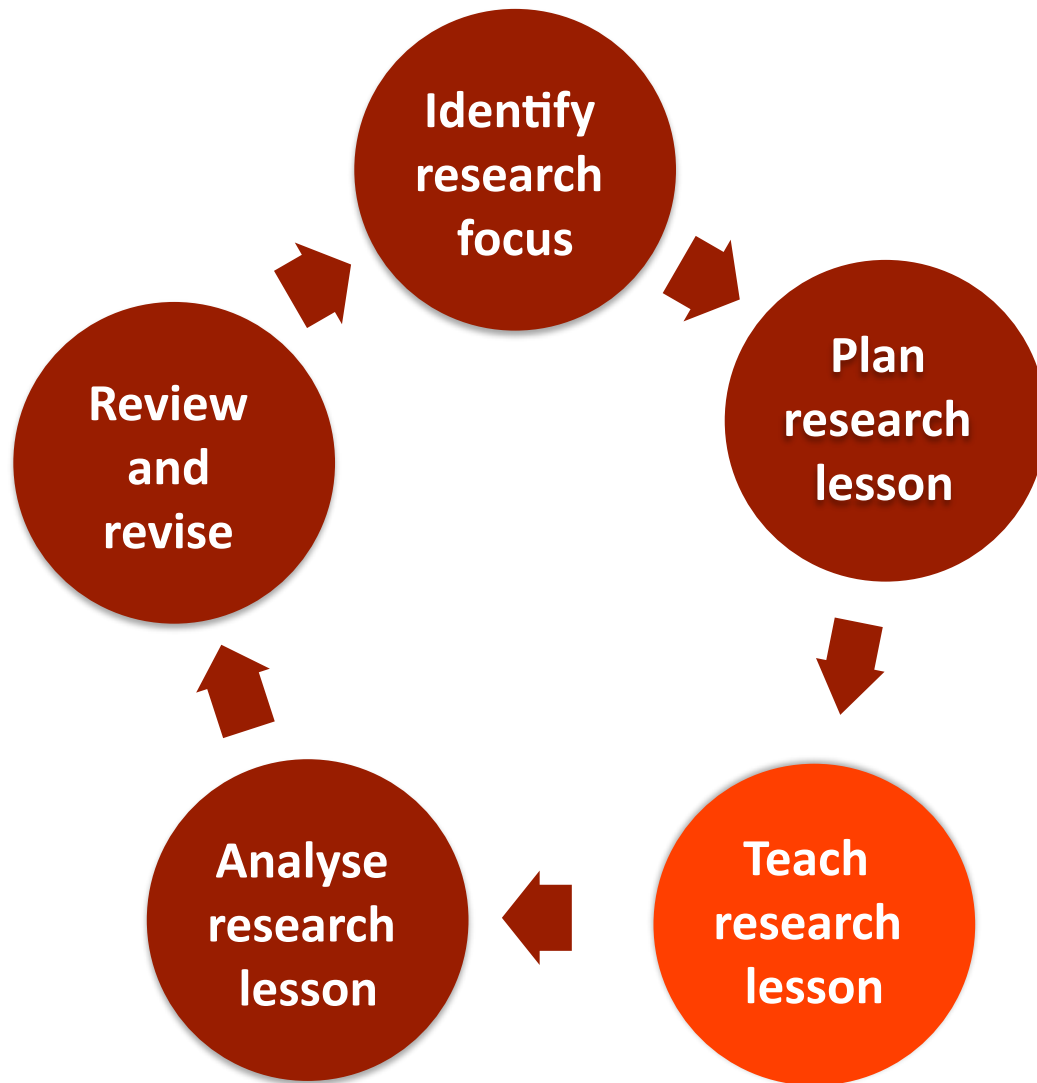
Over £5m budget

All get (B) $946000 \times 5.2 = 4919200$

Within £5m budget (80800)

$80800 \div 12 = 6733$ can have (A)

Japanese Lesson Study Model



Observe and describe:

- **Teaching:**
 - what are the most effective prompts and questions?
- **Learning:**
 - how do selected students respond mathematically?
 - what do they discuss?
 - how do they reason?
- **Mathematics:**
 - how does the mathematics flow and develop during the lesson?

The Pre-Lesson Briefing



As you observe the lesson make notes:

What evidence can you see of:

- Students planning the work they will do next?
- Students monitoring their solution approach as they work?

What teaching strategies help?


The Lesson

Outbreak !

...tting extremely serious.
...started to spread around the city.
...sease you only have hours to live.
...een put under quarantine; no one in or out.
...ws is you are able to help.

the Research and Development Department
...d have managed to put together two

...tive and costs £12.00 per vaccine.
...d costs £5.20 per vaccine.

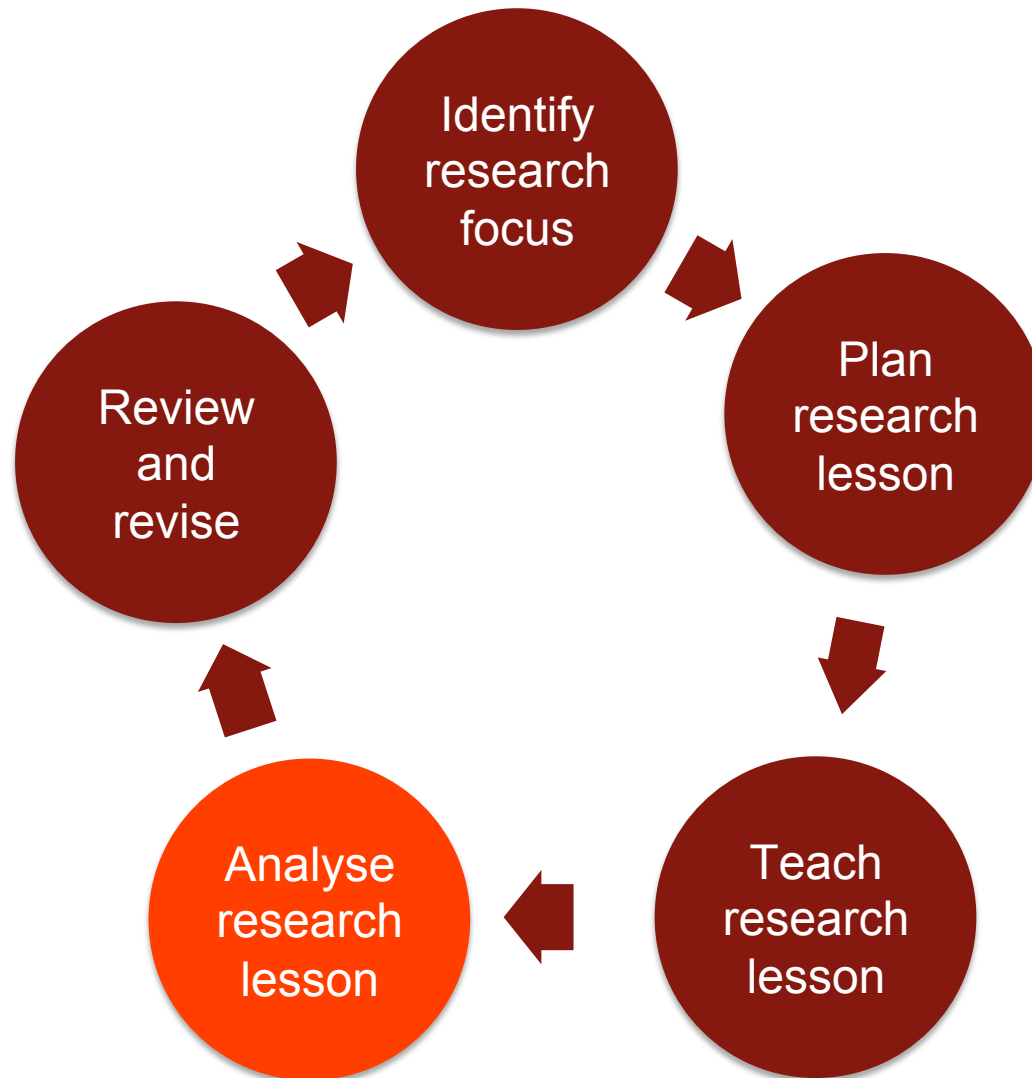


Number i
Populat

Summary of lesson structure

1. Recall the task
2. Review the task in silence.
3. Clarify the purpose of the task
4. Interpret and explain your partner's work
5. Produce a joint solution
6. Review the purpose of the task
7. Two pairs present solutions to the class
8. Plan for next time

Japanese Lesson Study Model



The post-lesson discussion

- Same day debriefing includes a facilitator, the teacher, observers, a commentator (koshi).
- Teacher describes the lesson; reasons behind decisions made; departures from the plan.
- Observers describe what they saw in the target students. Discussion focuses on the research question.
- Commentator relates observations to research and discusses implications for future.

Green sheet to encourage monitoring

Analysing Partner's work

1. Describe briefly what your partner has done.
2. Why do you think they have done this?
3. How is this different from your approach?
4. What impact will this have on your next attempt at the problem?

Planning fostered by interpreting each others' work



Choosing the presentations; Maths, Morals and Monitoring



Contribution by the “Koshi”

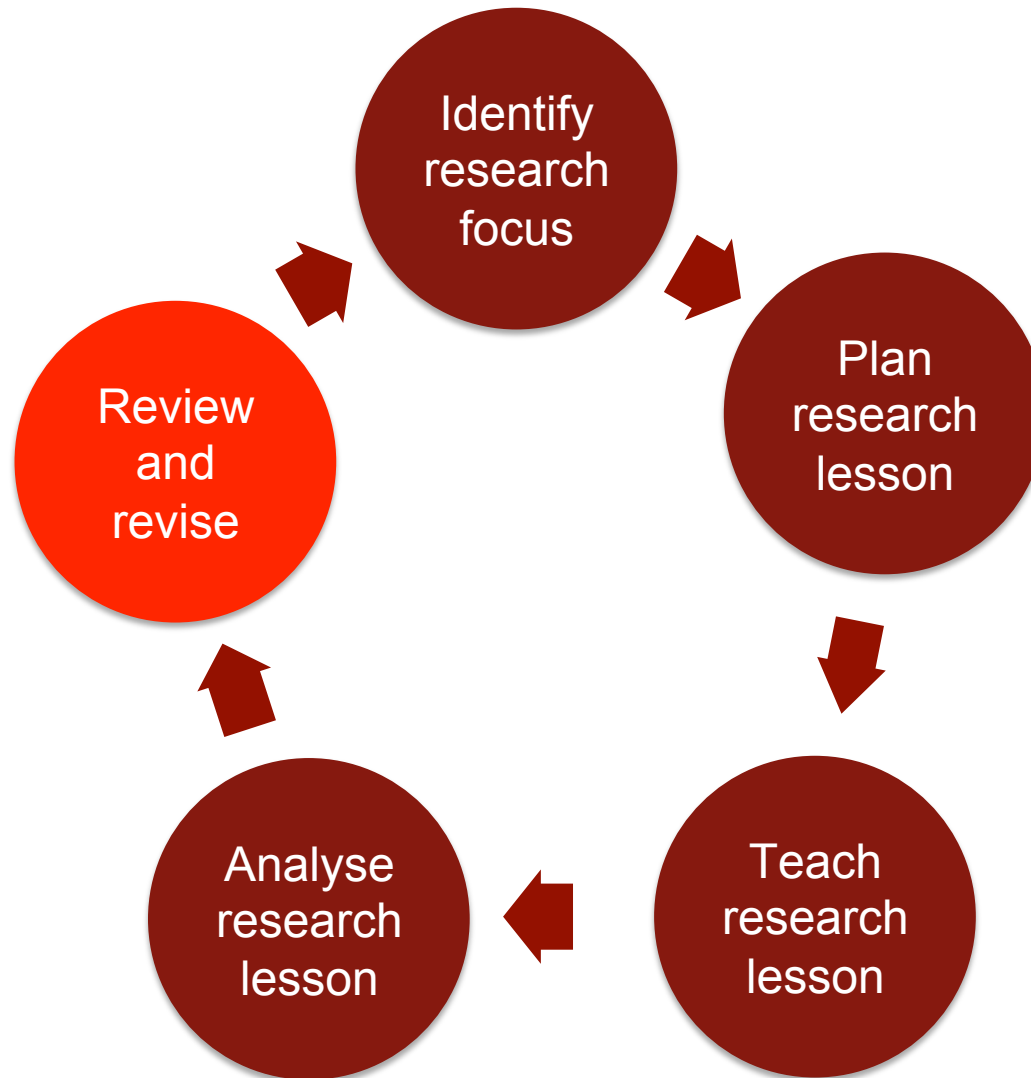


Issues arising: Planning and monitoring

Planning and monitoring were encouraged by:

- Stopping students and asking them to explain and plan:
 - “Pens down and tell each other what you are doing.”
- The teacher’s questioning:
 - “How do you know when the money will run out?”;
 - “Are we achieving our goal?”
 - “Could you do better than vaccinate everyone with B?”
- The redrafting of solutions:
 - “Put down the steps you were taking.”
- Critiquing other students’ work
 - These were carefully chosen to focus on two strategies.

Japanese Lesson Study Model



Review and revise

Teachers:

- Review the lesson objectives.
- Review each phase of the lesson, the flow, the timings, the prompts.
- Revise the tasks and questions.
- Revise the anticipated student responses - using actual responses.
- Use student work to illustrate success criteria.
- Reteach the lesson with another class.

What do teachers think about Lesson Study?



Mathematics Improvement Network

Thank you!
<Insert contact details>