LSCs, MSPs, SSIs, etc.:

Implications of Research on Federally-Funded Projects for Improvement of Mathematics Education District-Wide

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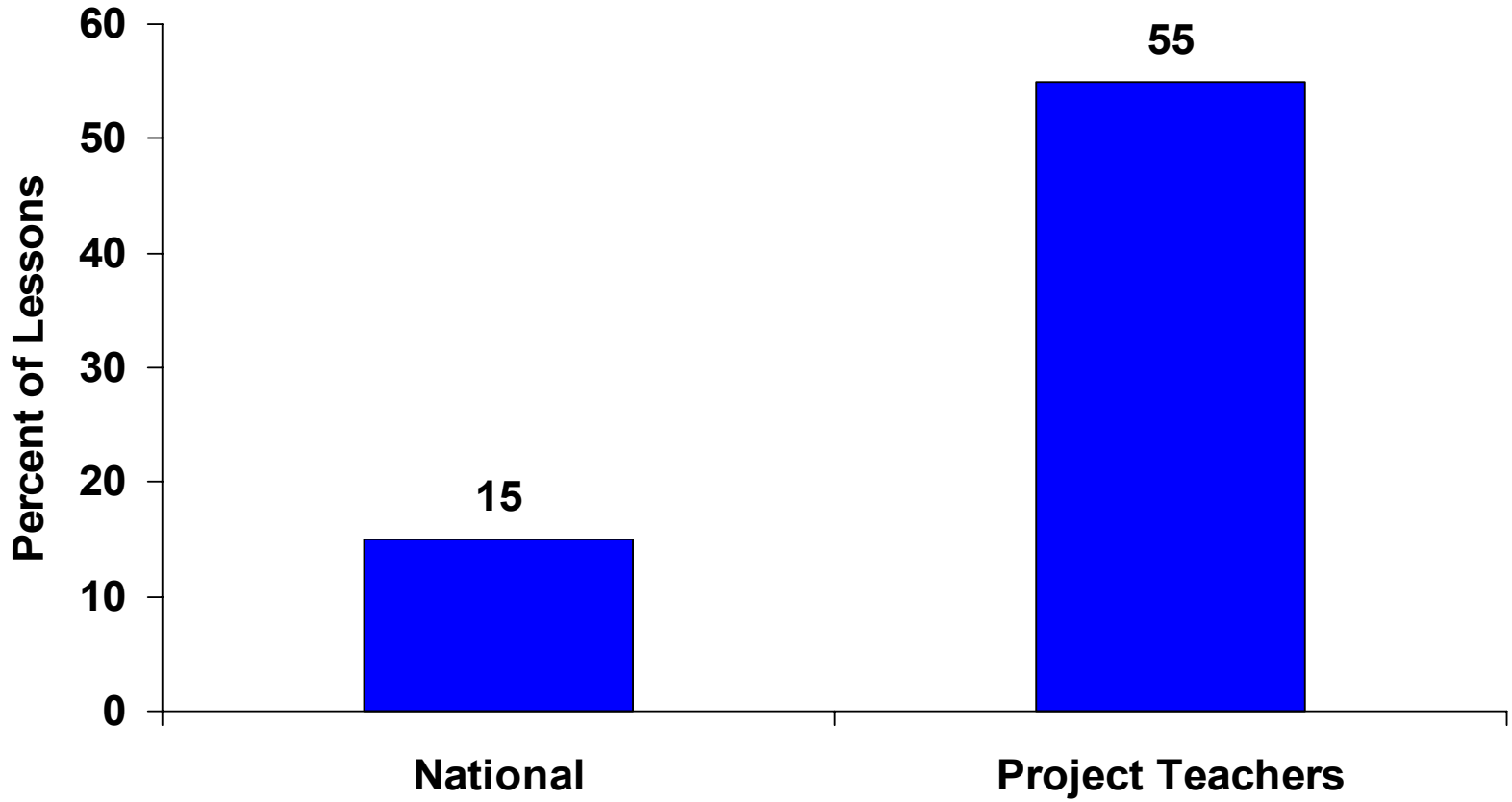
Look at the following graph.

Percent of K-12 Mathematics Lessons Rated Highly



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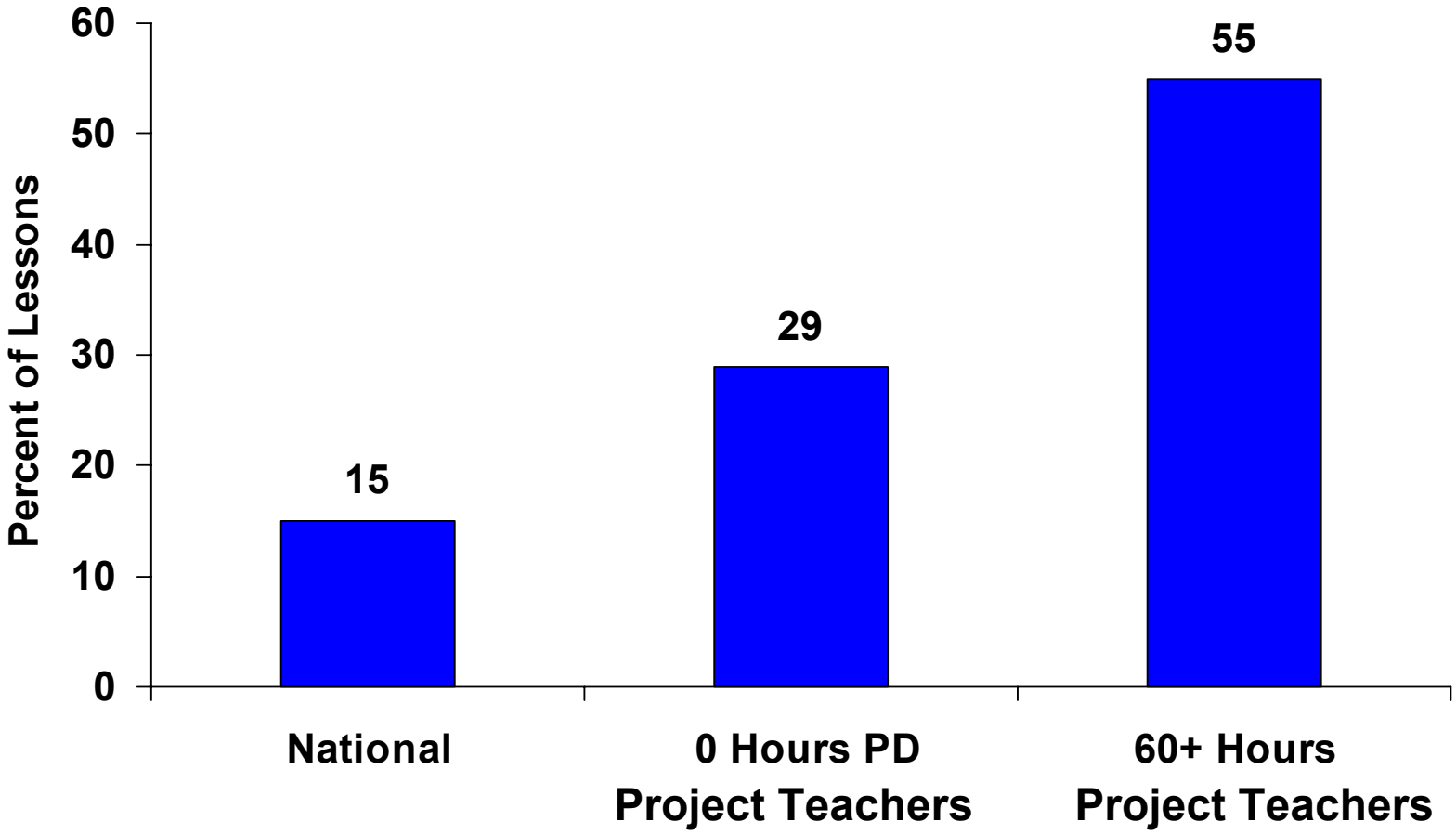
Based on this graph: How confident are you that this would be an effective program for your district? Why?

- Think about it individually
- Talk with a neighbor

Reason for skepticism #1

The professional development participants may have had better mathematics instruction to begin with.

Percent of K-12 Mathematics Lessons Rated Highly



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Reason for skepticism #2

The program may not be effective in your context:

- Teachers in your district might be different in important ways
- Your district may not have the capacity/ resources to implement the program with quality

My talk has several main points

1. There continues to be a gap between the research and practice communities.

2. Both communities would be better off if that gap were bridged.

3. But cautions are in order.

4. Researchers need to be honest about the limitations of our work

5. Practitioners should move ahead with their best understanding based on current evidence, but at the same time recognize the limits of that research.

I’m going to share some research findings/lessons learned I think are worth your consideration, as long as you keep their limitations in mind.

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Bridging the Gap Between Research and Practice

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“Scientifically Based Practice: It’s About More Than Improving the Quality of Research”

Deborah Stipek, Dean of Stanford’s School of Education, EdWeek, March 23, 2005.

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“Most research evidence is published in places and forms that only other researchers visit and can comprehend.”

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“Practitioners’ decisions are based primarily on their own intuitions and experience and occasionally on advice from colleagues, principals, or workshop leaders.”

Periodically researchers are asked to focus on problems of practice and make their findings accessible to practitioners.

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And practitioners are asked to base their practice on research.

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It makes little sense for teachers (or schools, or districts, or states) to continue practices that have been shown to be ineffective.

At the same time, both researchers who are asked to make sure their findings are utilized, and practitioners who are asked to base decisions on research, need to be appropriately skeptical about what counts as “evidence”.

Our research base is spotty and somewhat internally inconsistent, in part because:

- The education research enterprise is seriously underfunded.

- Researchers use different instruments to study the same phenomenon, so we don't know which differences among studies are "real" and which are due to different measures.

- Research reports don't tell us very much about the treatment, so even if we know "it" "works" we don't know what "it" was.

- There are few mechanisms or incentives for a coherent research enterprise focused on problems of practice.

The desire to close the research to practice gap results in pressure to act on findings before we can see if they "hold up" under further investigation

- "At the 95% level", means that 5 times out of 100, a "finding" will be due to chance.

- If we repeated a study 3 times, and got the same result, the probability of it being due to chance would be only 1 in 10,000.

- There is no such thing as a perfect study; when a variety of studies with different limitations reach the same conclusions, we can have more confidence in those results.

- Systematic replication of studies in different contexts would give us a better idea of where those findings might apply, and to whom.

Researchers need to be honest about the limitations of what our research tells us, including what alternative explanations there might be for the particular results, and to whom the results might apply.

Practitioners need to do a bit of a balancing act—you definitely shouldn't ignore research, but neither should you rush to accept and act on the results of whatever study seems to be in vogue at the moment.

We are sometimes saved by the conservatism of experienced teachers, with their reluctance to take on “fads” that don’t make sense to them, or abandon practices that they have found to be effective.

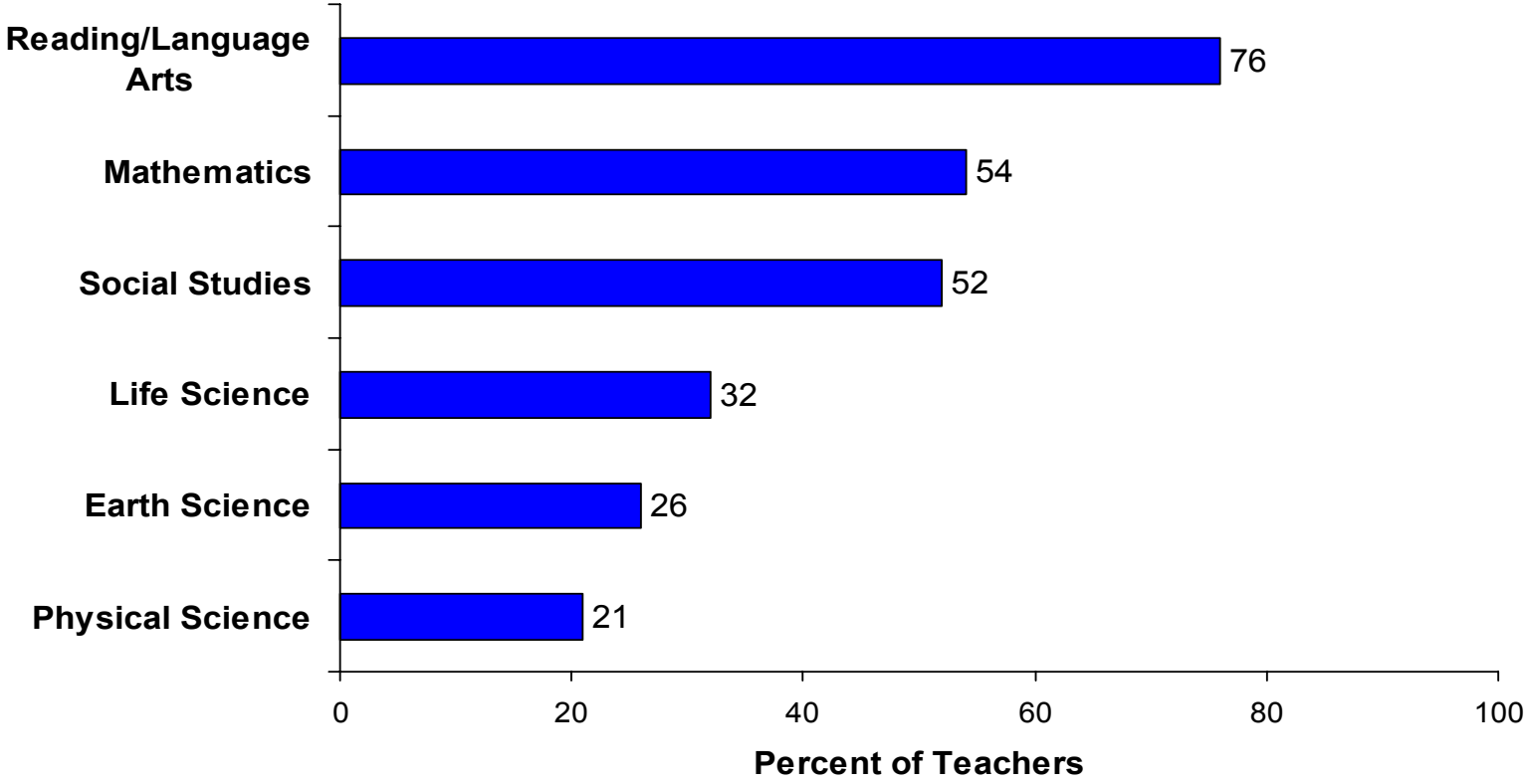
Predictions

- What percent of elementary teachers consider themselves very well qualified to teach mathematics? Reading/language arts?
- What percent of teachers (K-4, 5-8, 9-12) indicate at least a moderate need for professional development to deeper their mathematics content knowledge?
- What percent of teachers (K-4, 5-8, 9-12) spent less than 6 hours on mathematics-related professional development in the last three years?

2000 National Survey of Science and Mathematics Education

- Limitation: Teacher self report

Elementary Teachers Considering Themselves Very Well Qualified to Teach Each Subject



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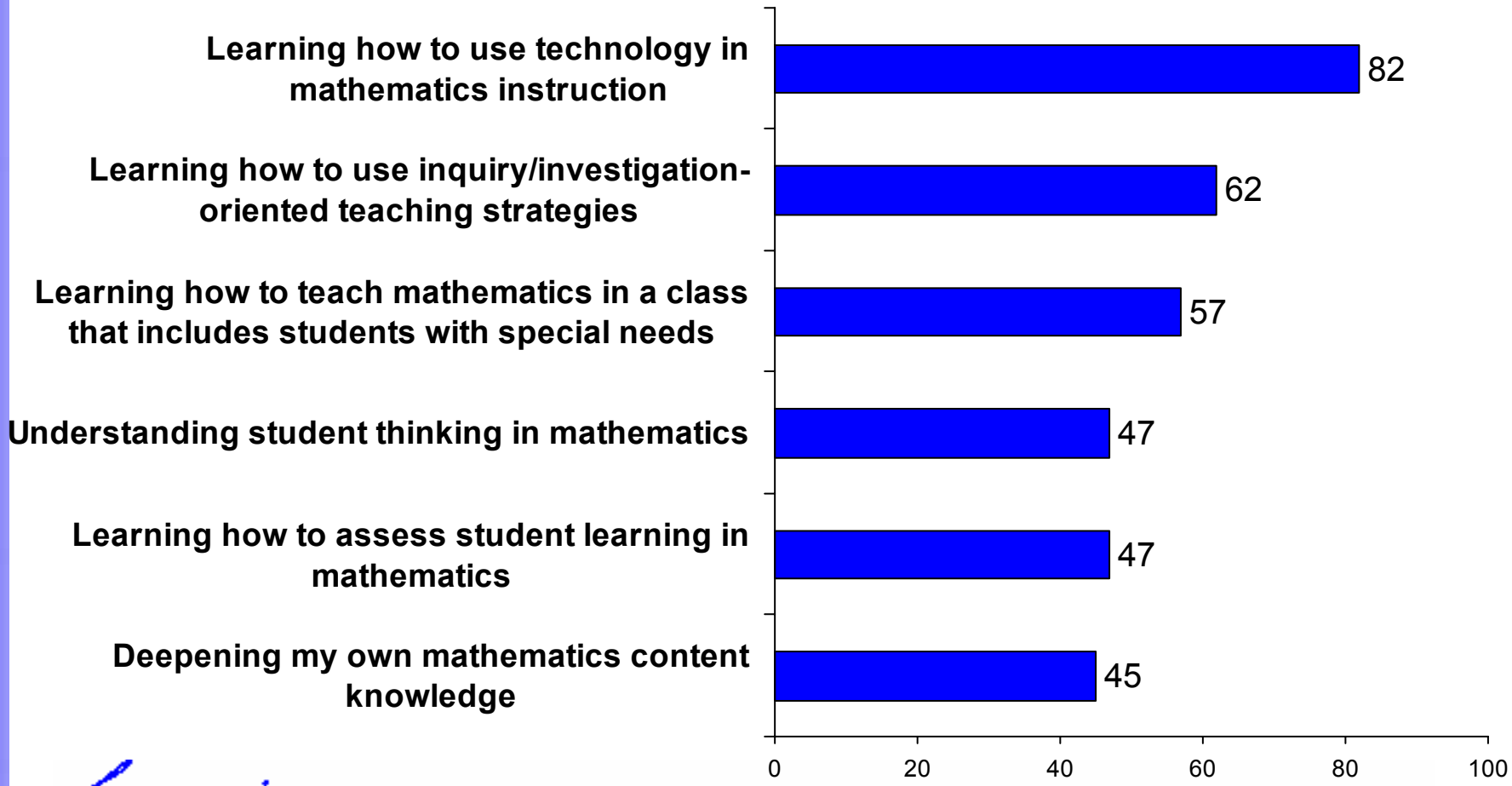
Grade K-4 Mathematics Teachers' Perceptions of Their Professional Development Needs



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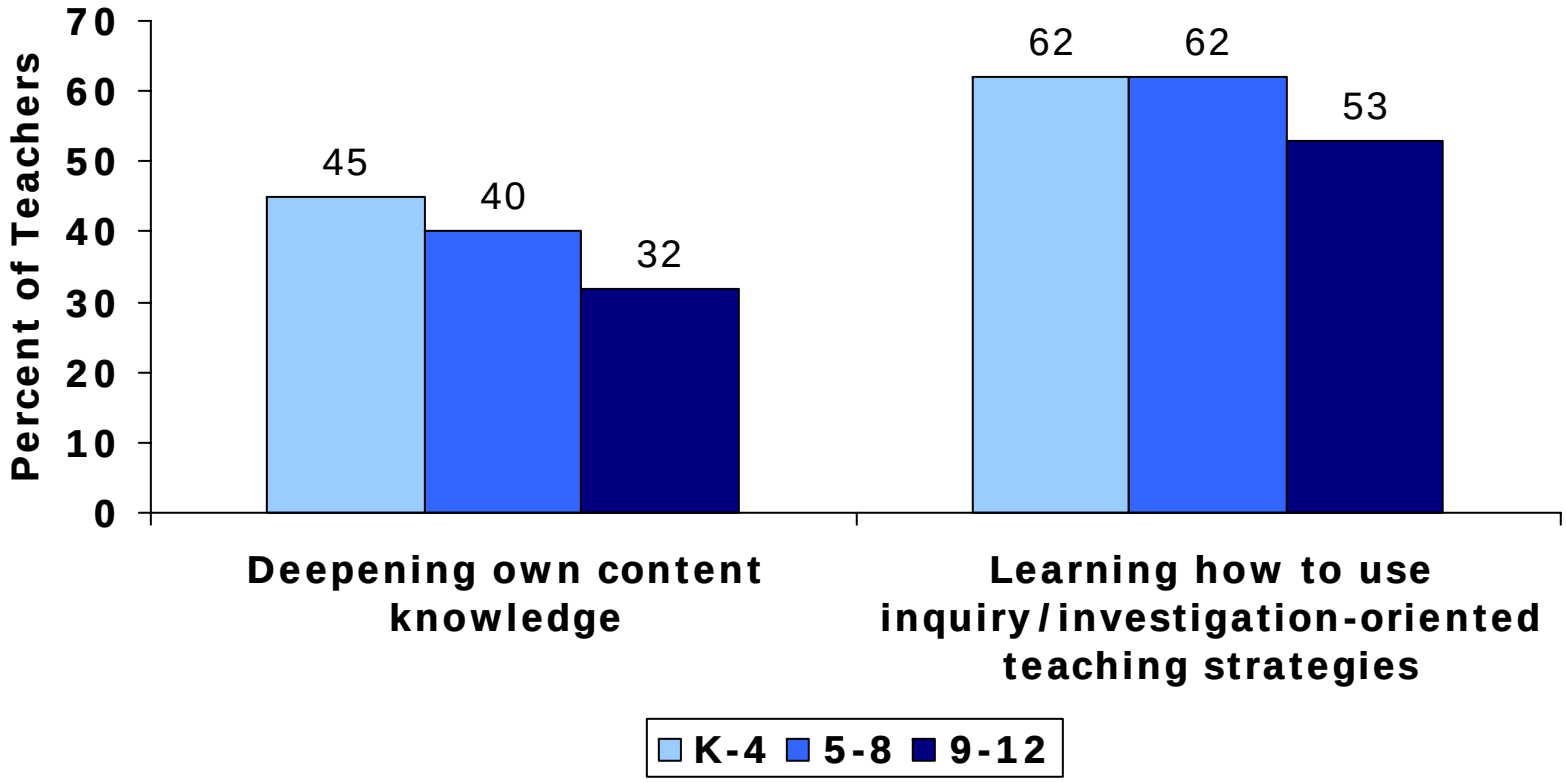
Teachers' Perceiving a Moderate or Substational Need for Professional Development, by Grade Range



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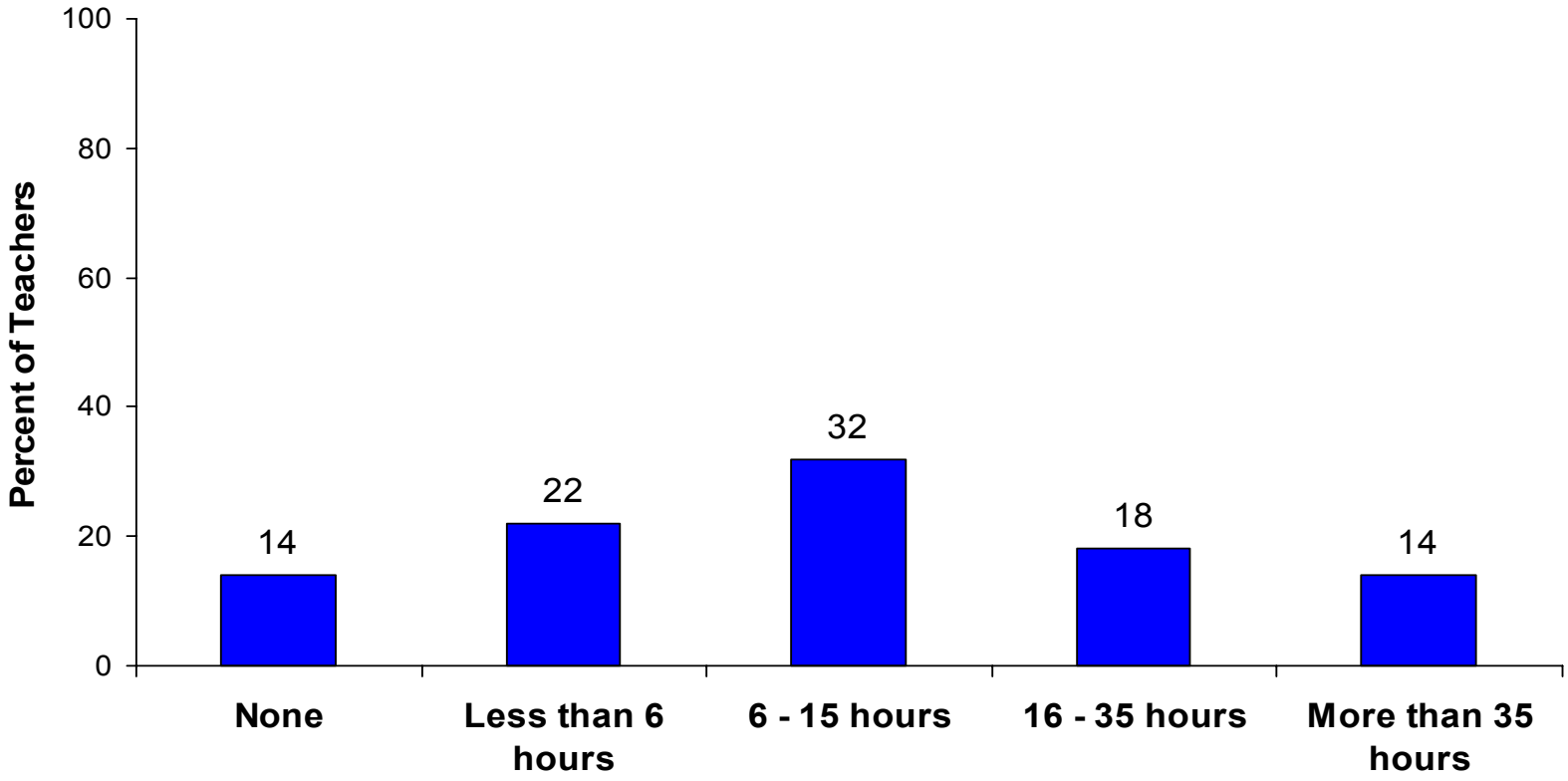
Time K-4 Teachers of Mathematics Spent on Mathematics-related In-Service Education in Preceding Three Years



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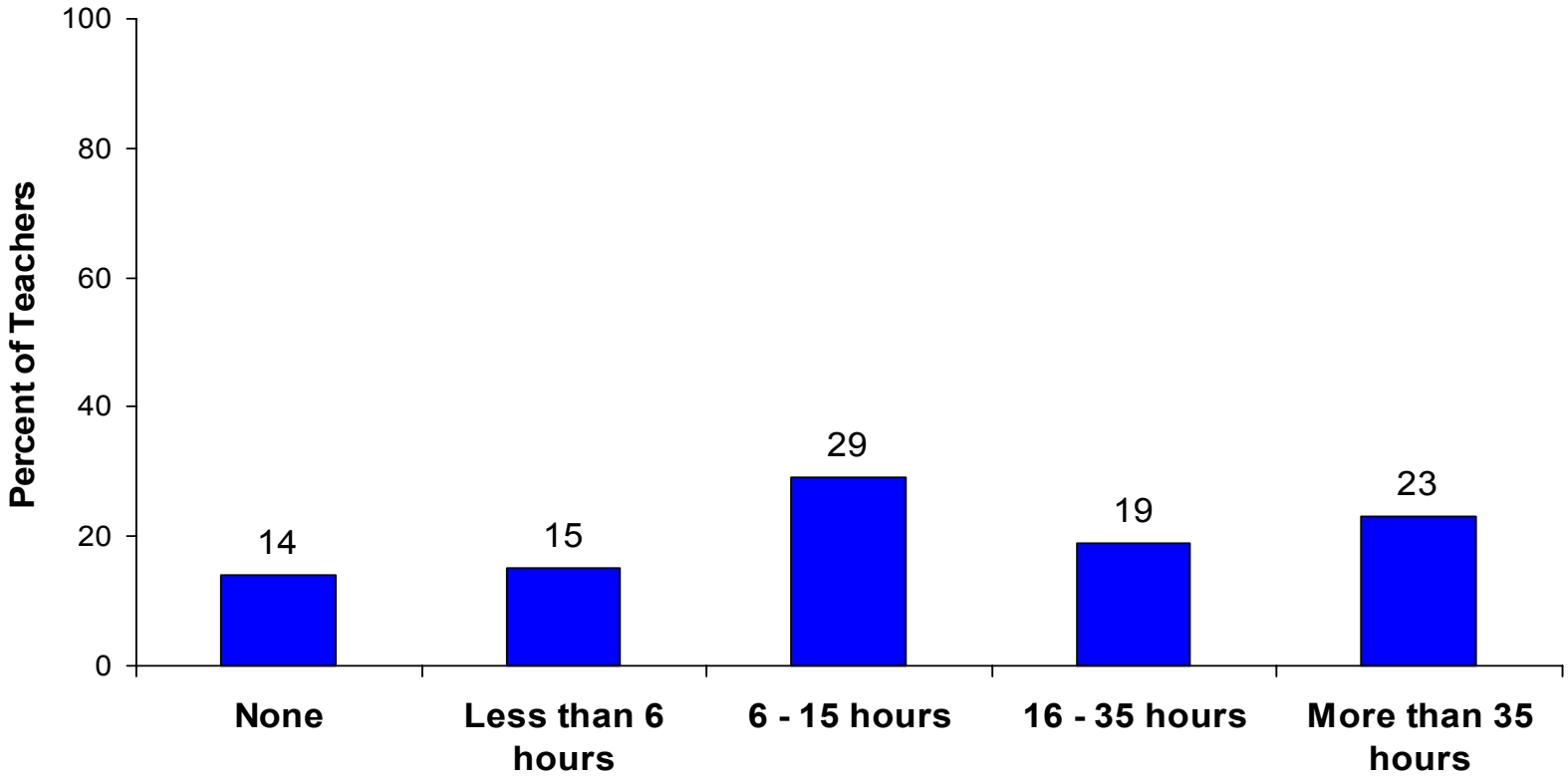
Time 5-8 Teachers of Mathematics Spent on Mathematics-related In-Service Education in Preceding Three Years



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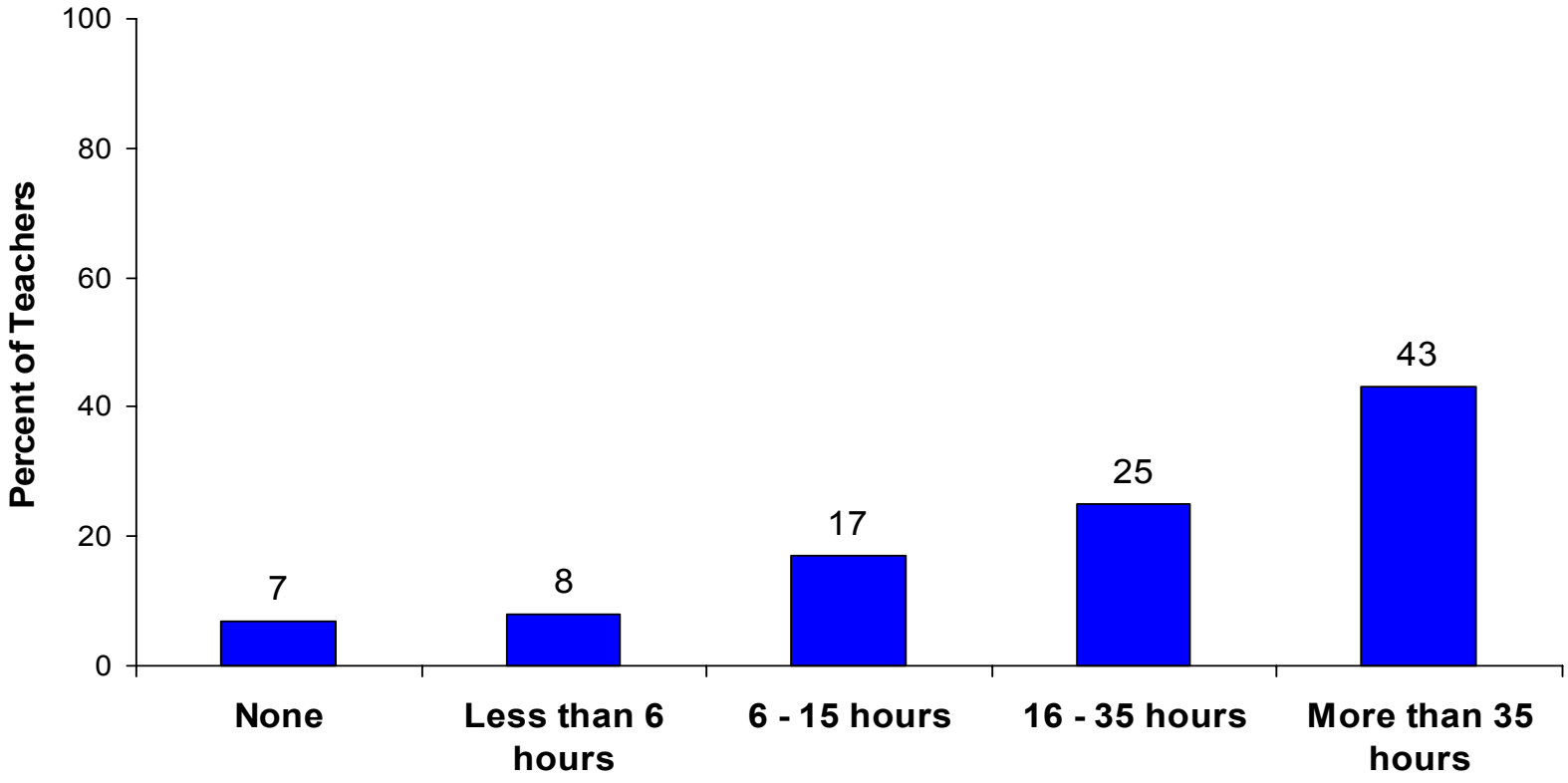
Time 9-12 Teachers of Mathematics Spent on Mathematics-related In-Service Education in Preceding Three Years



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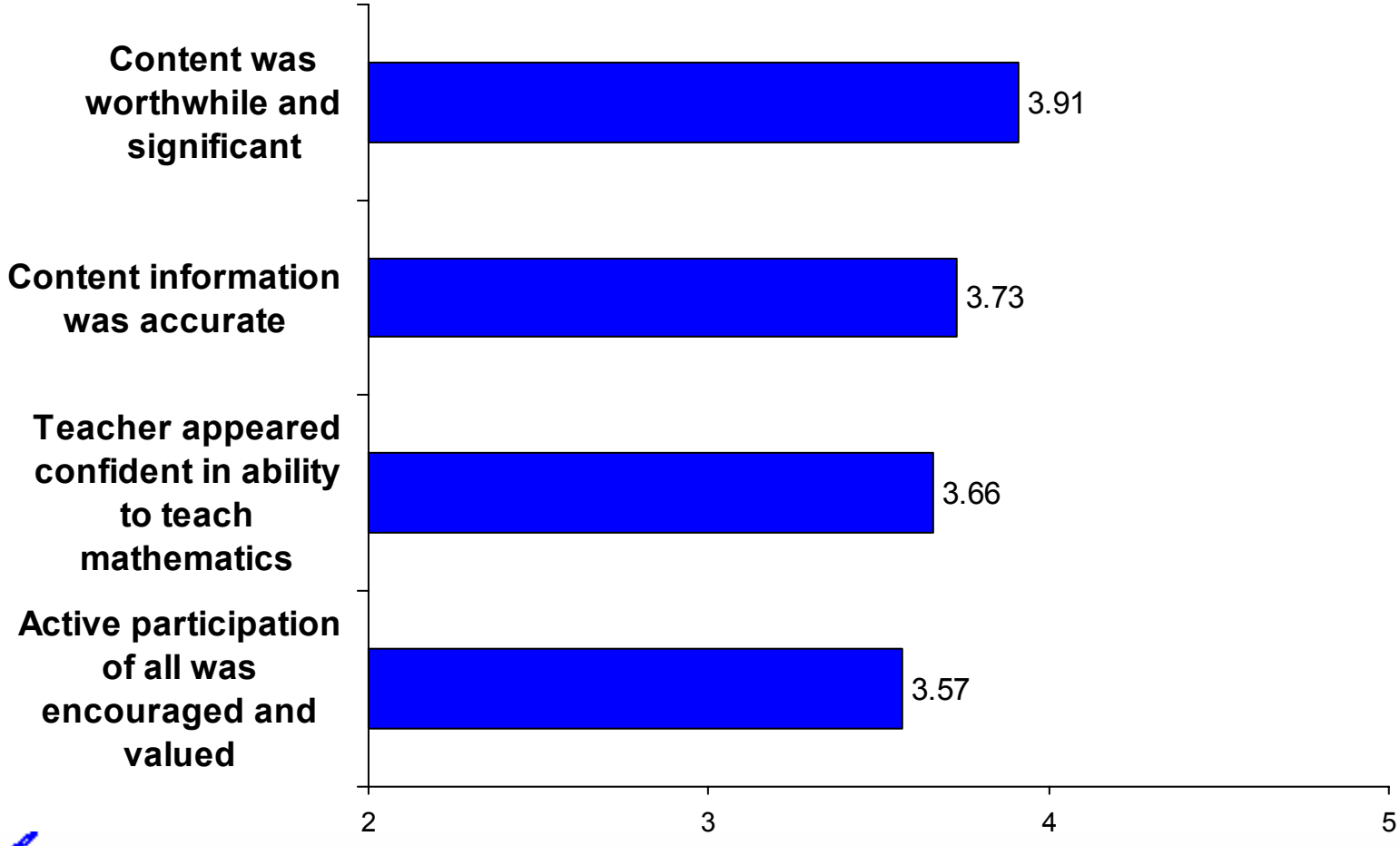
Student Opportunity to Learn

- Based on a national observation study of a representative sample of mathematics and science lessons

- Limitation: small sample

National Observation Study: Relative Strengths of Elementary Mathematics Lessons



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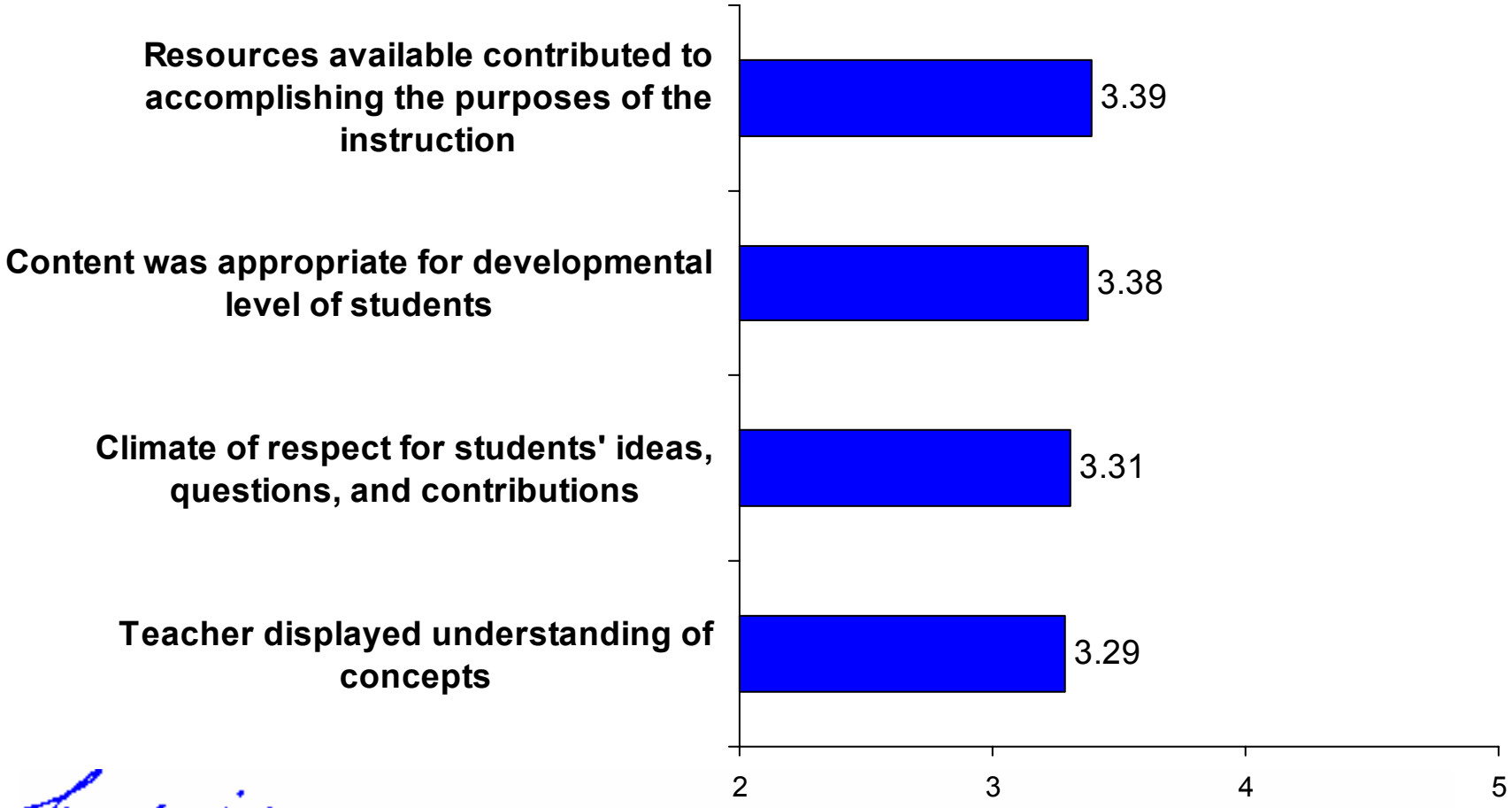

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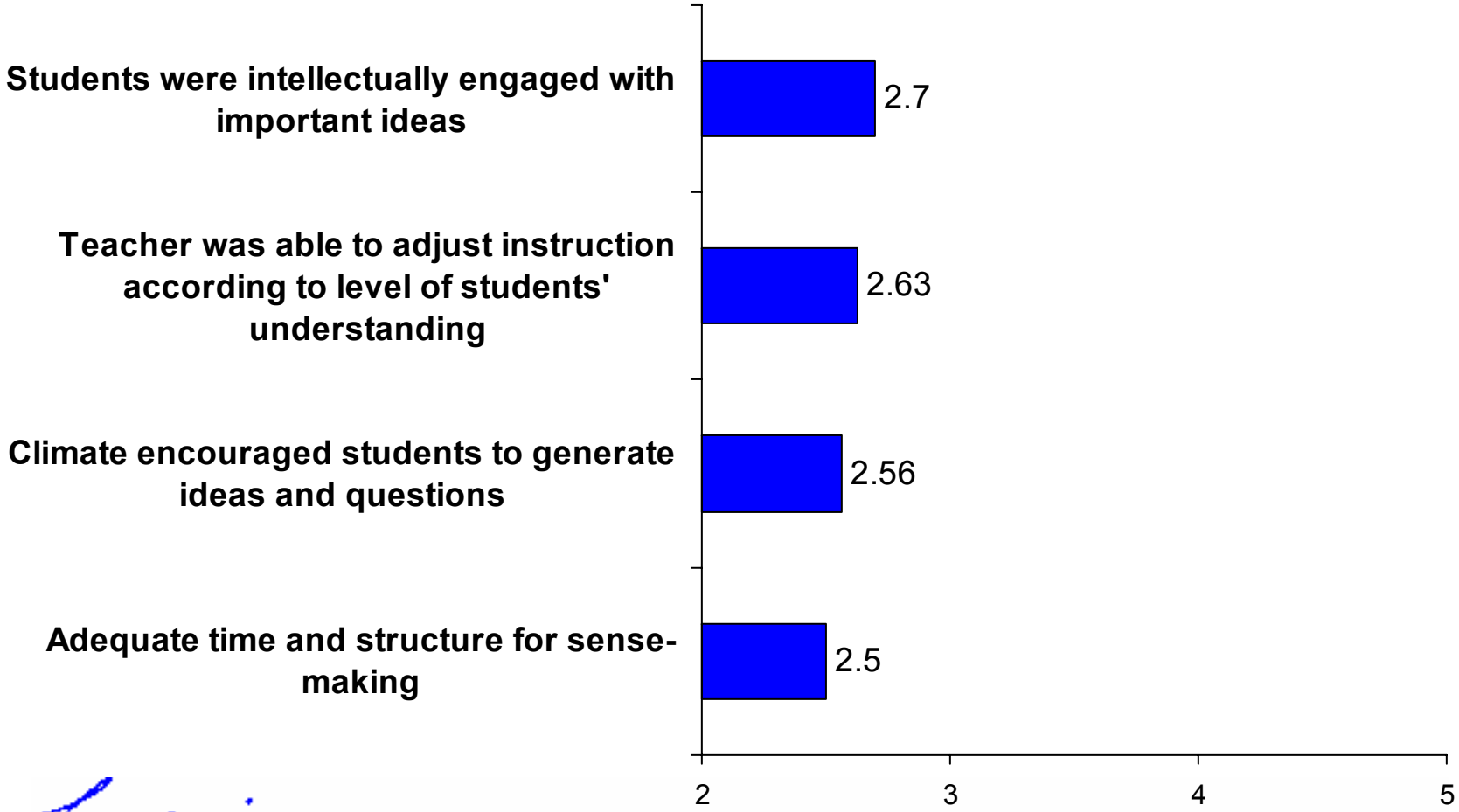
National Observation Study: Relative Weaknesses of Elementary Mathematics Lessons



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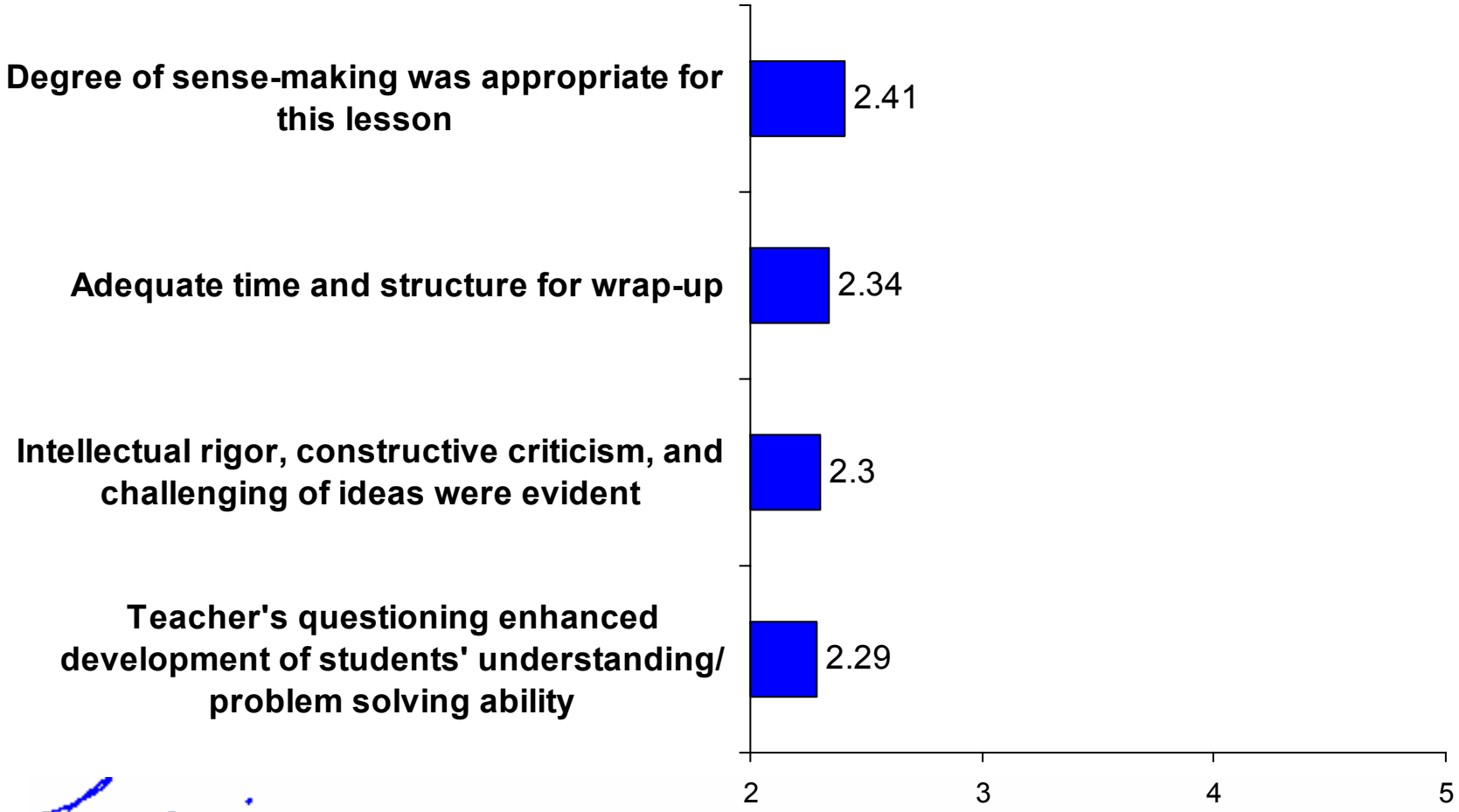
National Observation Study: Relative Weaknesses of Elementary Mathematics Lessons



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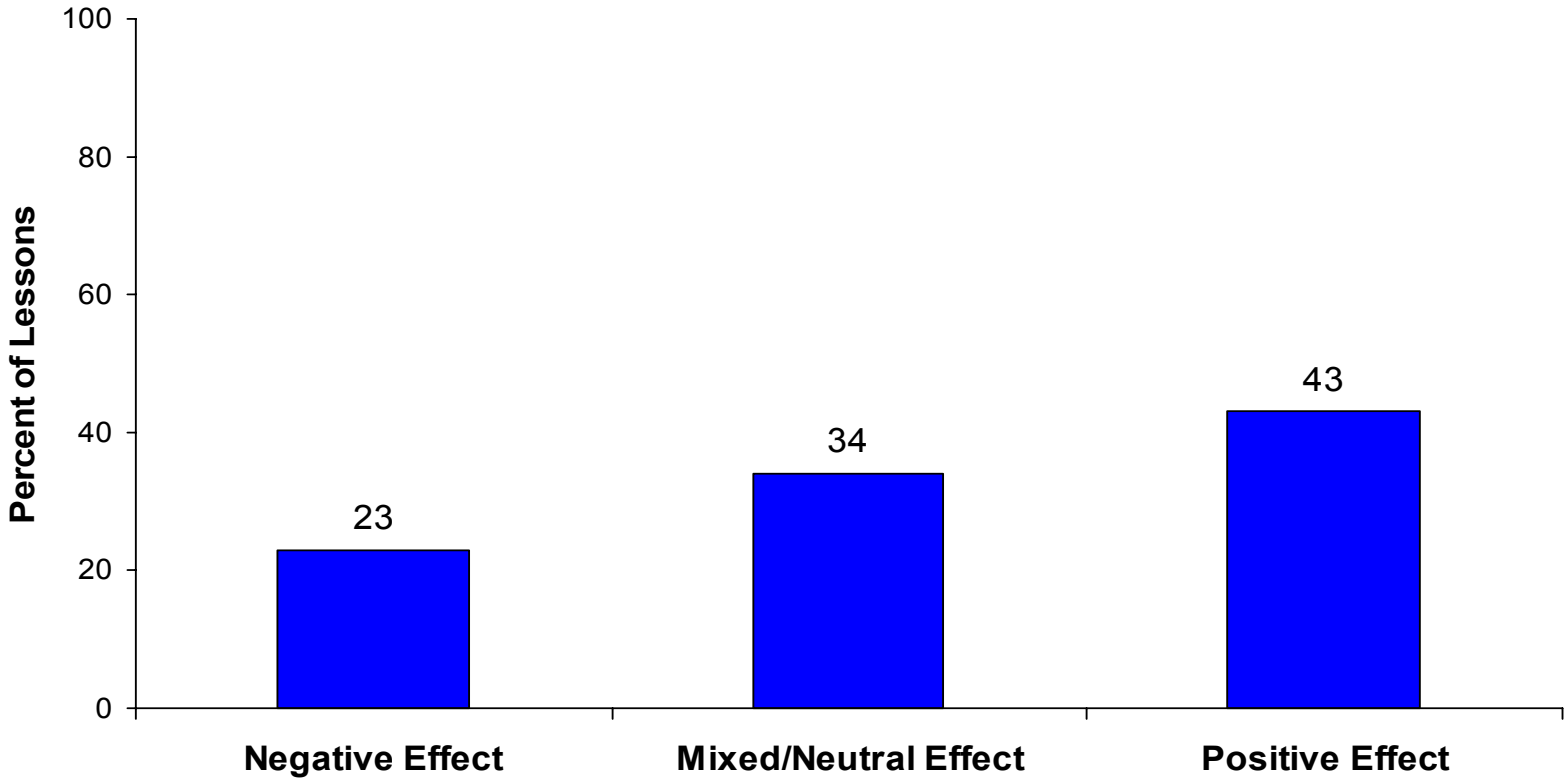
Likely Impact on Students' Interest in and/or Appreciation for the Discipline



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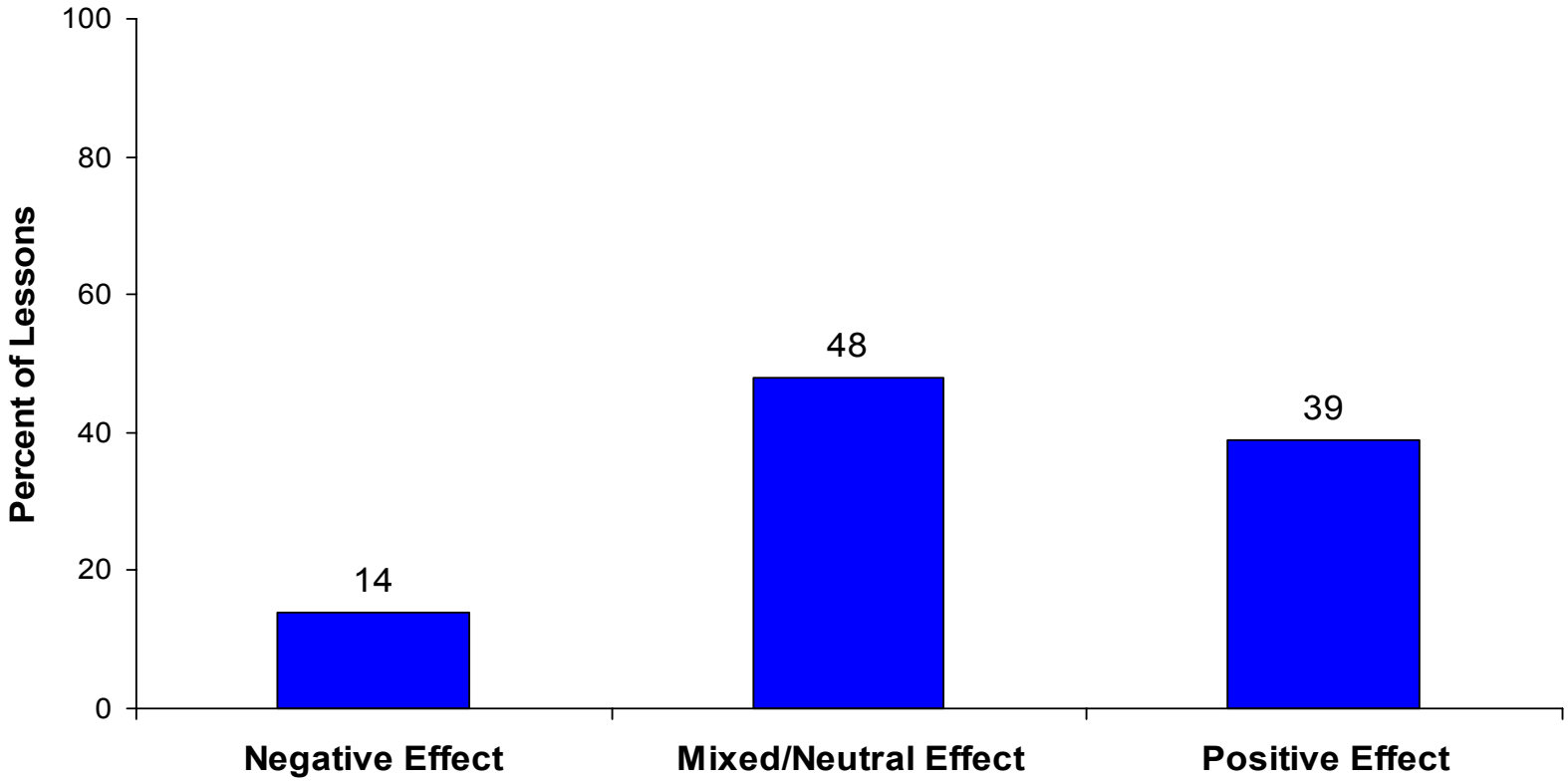
Likely Impact on Students' Understanding of Important Mathematics Concepts



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Capsule Rating

Level 1: Ineffective Instruction

Passive "Learning"

Activity for Activity's Sake

Level 2: Elements of Effective Instruction

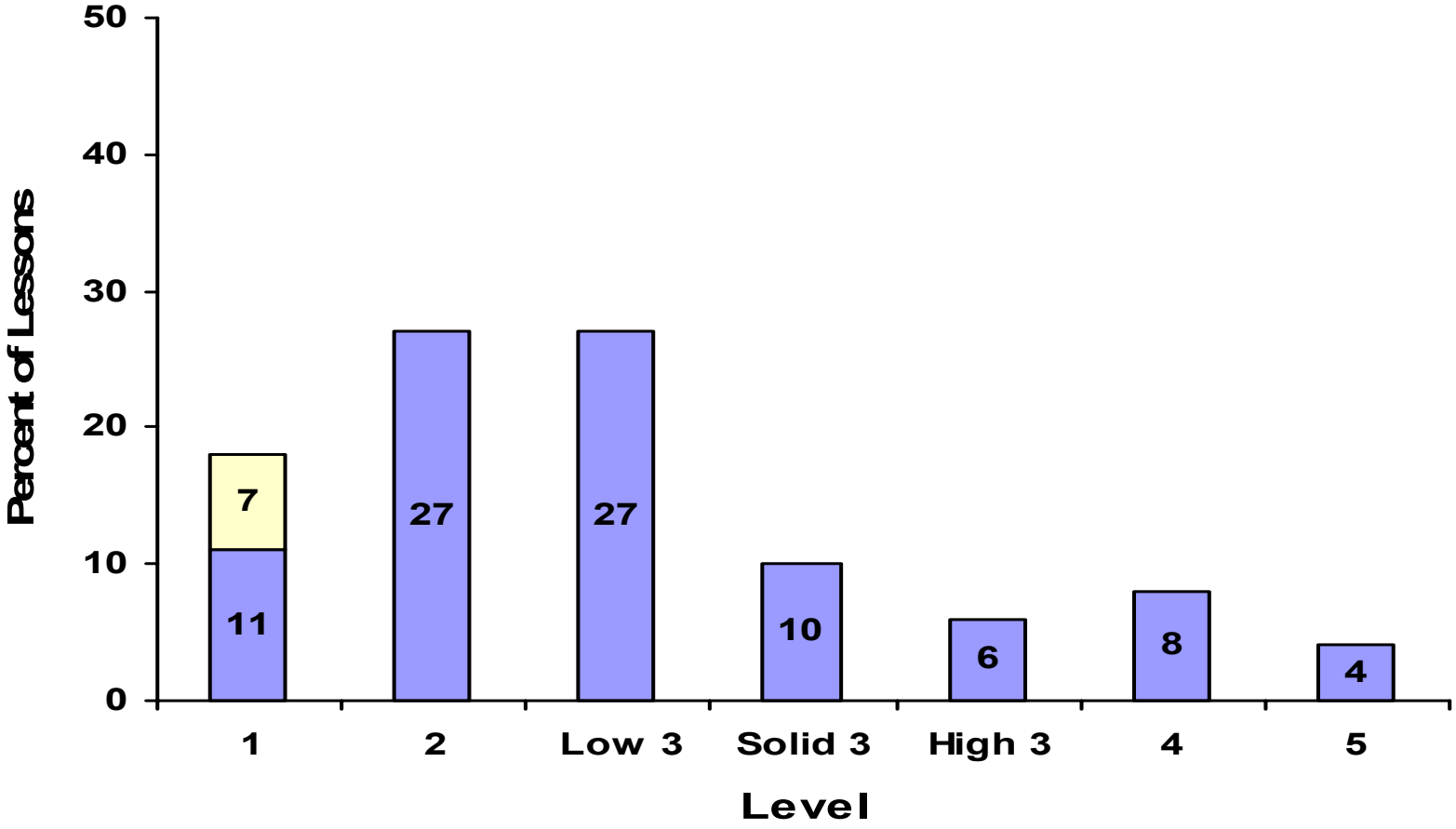
Level 3: Beginning Stages of Effective Instruction (3 levels)

Level 4: Accomplished, Effective Instruction

Level 5: Exemplary Instruction

Rating based on the observer's assessment of the likely impact of the lesson on students' understanding of mathematics or their capacity to successfully "do" mathematics

Overall Ratings of Elementary Mathematics Lessons



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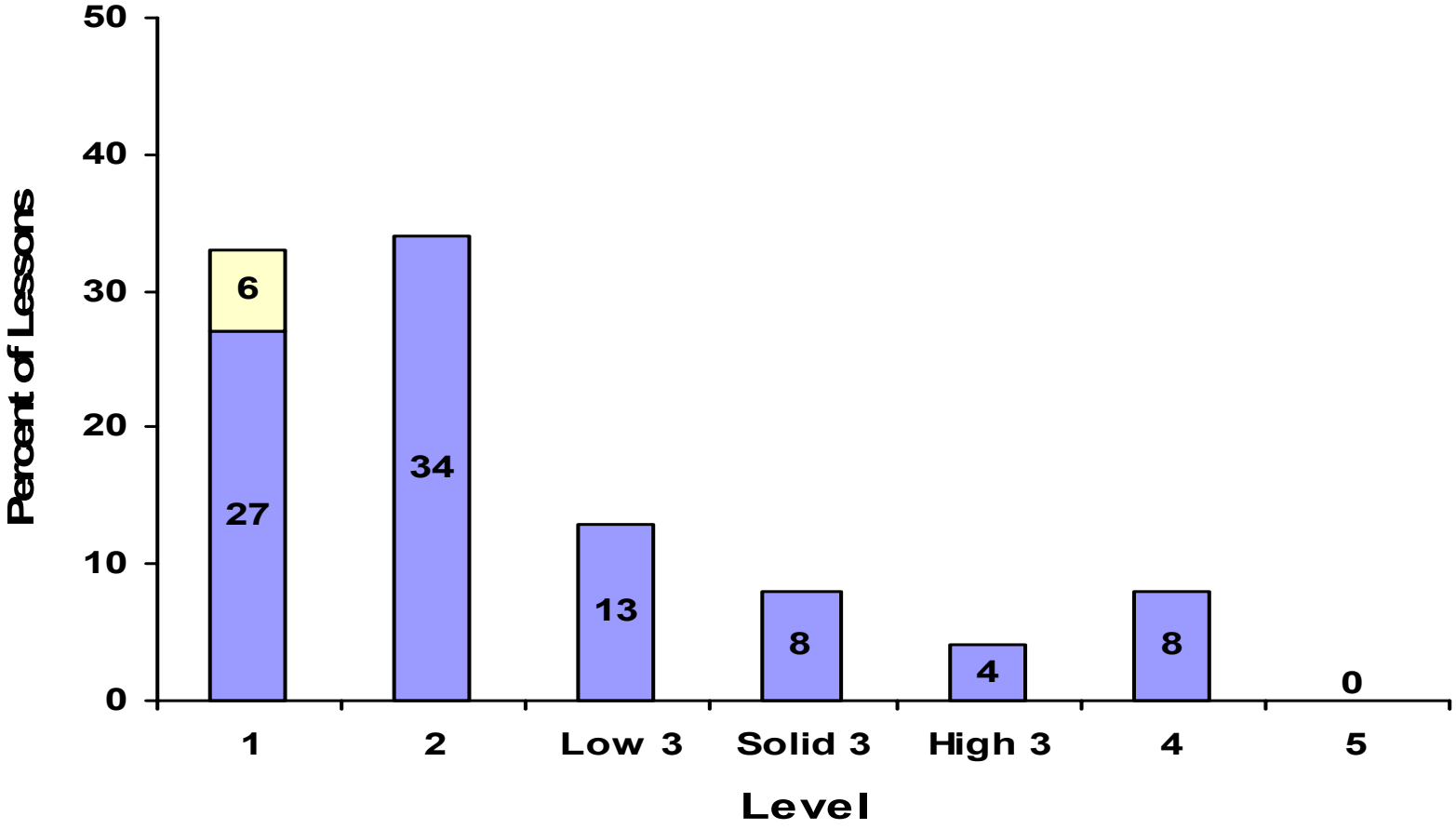
Overall Ratings of Secondary Mathematics Lessons



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What distinguished good lessons from bad lessons tended to be the extent to which:

- The lesson had important mathematics learning goals AND the nature of the tasks provided opportunities for students to learn the content;

- The learning environment was not only respectful of students, but also challenging to them; and

- The teacher's questions and explanations pushed student thinking and helped them make sense of the mathematics.

The lesson had important mathematics learning goals AND the nature of the tasks provided opportunities for students to learn the content

The teacher distributed crayons and worksheets to the children in this 1st grade class.

"Today, we're going to find differences for facts of 5. What did I say?"

(Students repeat).

"When we say difference, does that mean add or subtract?

Jonathan?"

Jonathan: *"Add?"*

Teacher repeats what she said.

Another student says: *"Subtract?"*

Teacher: *"That's right."*

Teacher: *"Before we start, I want to pass out these mats and counters. Take 5 counters out of the bag. Place them on the top line of the mat. Now, put three white counters on the bottom. If I tell you 5 plus 3, are you going to add everything or take something away?"*

Kids: *"Take away".*

Finally someone says, *"Add".*

Teacher: *"If I say nine minus five, how many are you going to take away?"*

Students call out every number except 5.

Teacher (getting impatient): *"You're not listening."*

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Said the observer, "*It was simply a bunch of stuff that kids had to learn because their teacher said so. Students did not understand what they were doing or why they were doing it.*"

We saw well-designed lessons that were "reform-oriented", "traditional," and a blend of the two.

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An environment conducive to learning: respectful and rigorous

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An observer described the culture in a 3rd grade mathematics class as "phenomenal," noting that "at any given point there was an extraordinary amount of excitement, and the content was new and rigorously-taught for this bunch of students. Students appeared to be very comfortable participating and answering the teacher's questions, even when they were unsure of the correct answer."

An observer described how a 5th grade mathematics teacher was able to create an intellectually stimulating and demanding environment in a class comprised of students of widely varying ability levels. “She was highly skilled in keeping the environment non-threatening while designing a learning task that required participation by all the students at some level. The classroom culture was one of serious work, and the problems the students were asked to solve showed high regard for their intellectual capacities.”

Respectful, but not rigorous

Other lessons could be categorized as respectful, but lacking in rigor. Observers used terms like “pleasant, but not challenging” to describe such lessons.

"The culture suffered from a lack of focus on the intellectual content, however. The teacher appeared more intent on the students having a positive experience with math through completing the task than really engaging with the concepts. The classroom was a welcoming environment for students, and there was a focus on 'learning,' but the level of learning expected seemed rather low."

Lacking in Respect

Some lessons were judged to be lacking in respect, in some cases even hostile and demeaning to students.

The observer noted that “There was little concern for learning and even less respect for the students as individuals” in this 2nd grade mathematics lesson. “Students were criticized and told they were wrong but only occasionally helped by the teacher. Students who tried to contribute ideas ran a substantial risk of being told to stop. Most ideas from the students were met with a statement like the one given to a girl in the class, *‘Angelique, please let me be the teacher.’*”

Questioning is a weak point of many lessons

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The observer noted that the entire lesson consisted of a whirlwind of lower level, factual, and procedural questions. For 40 minutes the teacher asked students in this 5th grade class questions about:

- the metric system
- the meaning of base 10
- place value
- multiplication
- division
- fractions
- decimals
- mixed numbers
- improper fractions
- fraction names for 1
- equivalent fractions
- simplifying fractions
- divisibility rules for 2, 3, 5 and 10
- writing numbers in base 5 and 3
- place value in these two bases
- changing mixed numbers to improper fractions
- defining fractions as division
- pulling up real world occupations that use fractions
- comparing fractions using cross multiplication and common denominators
- changing a fraction to a decimal then to a percent

Professional Development to Improve Instruction

- "We're putting them out in immediate need of a 50,000 mile tune-up." (Ken Mechling, Clarion University

- While improvements in pre-service education are vital, in the meantime, we need to work with the teaching force we have.

Logic Model of Professional Development

Quality of PD Program

↓

Increased Teacher Knowledge/Skills

↓

Improved Classroom Practice

↓

Improved Student Performance

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Emerging Consensus on Effective Professional Development

- Content-focused
- Connected to practice
- Engages teachers in active learning
- Fosters collaboration among teachers
- Sustains focus over time

Local Systemic Change Initiative

- NSF funded the first cohort of Local Systemic Change (LSC) projects in 1995
- A total of 88 projects were funded by 2002
- Projects represent a wide variety of contexts – rural, suburban, urban districts, with widely varying demographics

Logic Model of LSC Professional Development

Quality of PD Program

↓

Increased Teacher Knowledge/Skills

↓

Improved Classroom Practice

↓

Improved Student Performance

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Local Systemic Change Initiative

- Targeted all teachers in a jurisdiction for professional development (minimum 130 hours)
- Emphasized preparing teachers to implement project-designated mathematics/science instructional materials in their classes
- Promoted efforts to build a supportive environment for improving science, mathematics, and technology instruction

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Core Evaluation Activities

- Interviews with PIs to understand the project approach
- Observations of professional development activities
- Teacher and principal questionnaires
- Classroom observations
- Teacher interviews

Strengths of the Evaluation

- Triangulation of data sources
- Interventions used in multiple contexts
- Lots of data (e.g., 75,000 teacher questionnaires), allowing longitudinal analysis and use of HLM and other sophisticated analyses.
- Replication of studies – different cohorts of projects, addressing elementary and secondary mathematics, elementary and secondary science

Weaknesses

- Quality control of observations was problematic
- Lack of data on impact on students

LSC professional development had a positive impact on teachers':

- Attitudes toward reform-oriented teaching in mathematics
- Perceptions of their content and pedagogical preparedness

- Limitation: based on teacher self-report data

- Typical participation was roughly 40 hours, not even close to 130 hour "minimum"

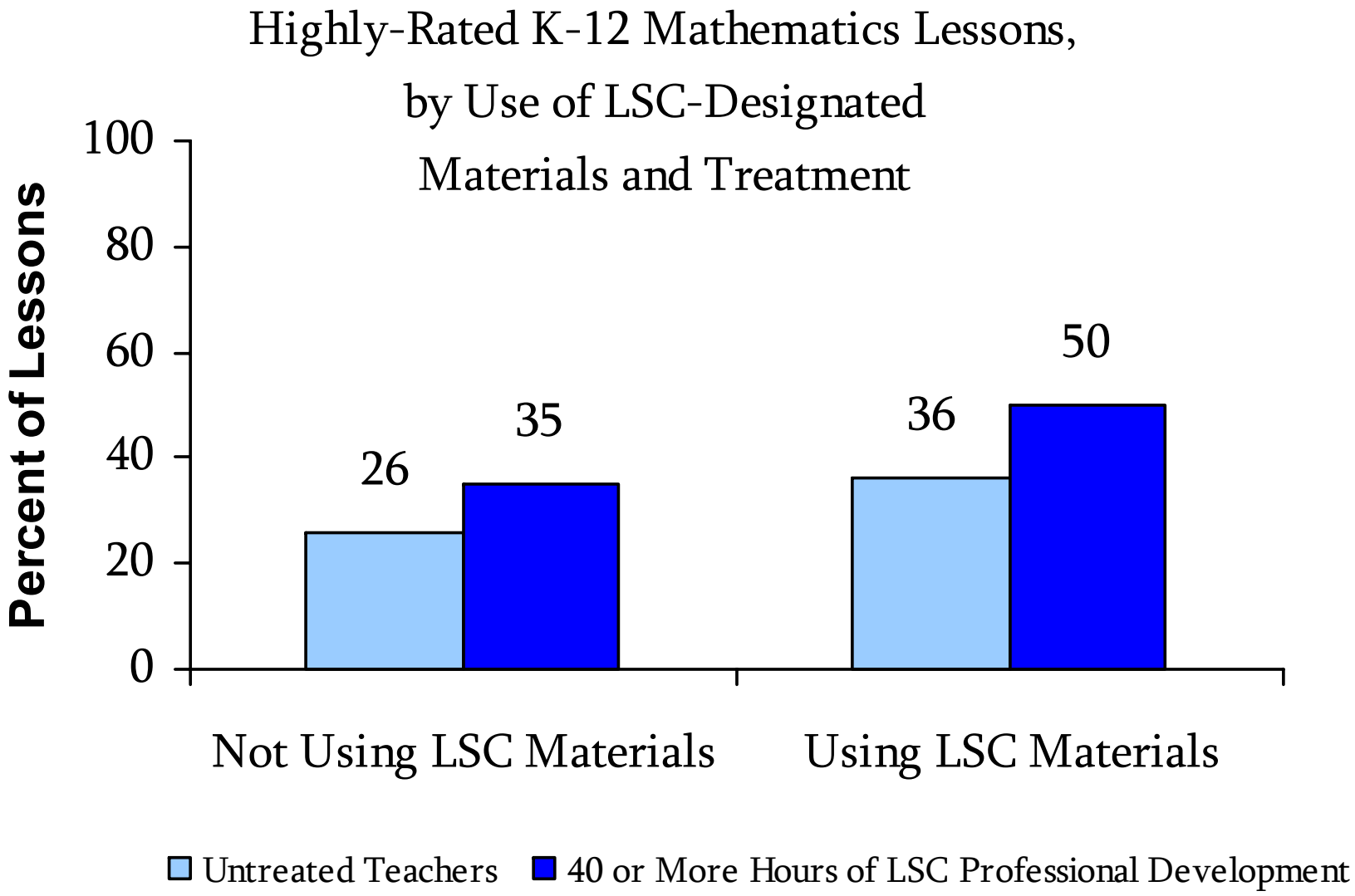
LSC professional development had a positive impact on classroom practice:

- Increased use of designated instructional materials
- Enhanced quality of content presented to students

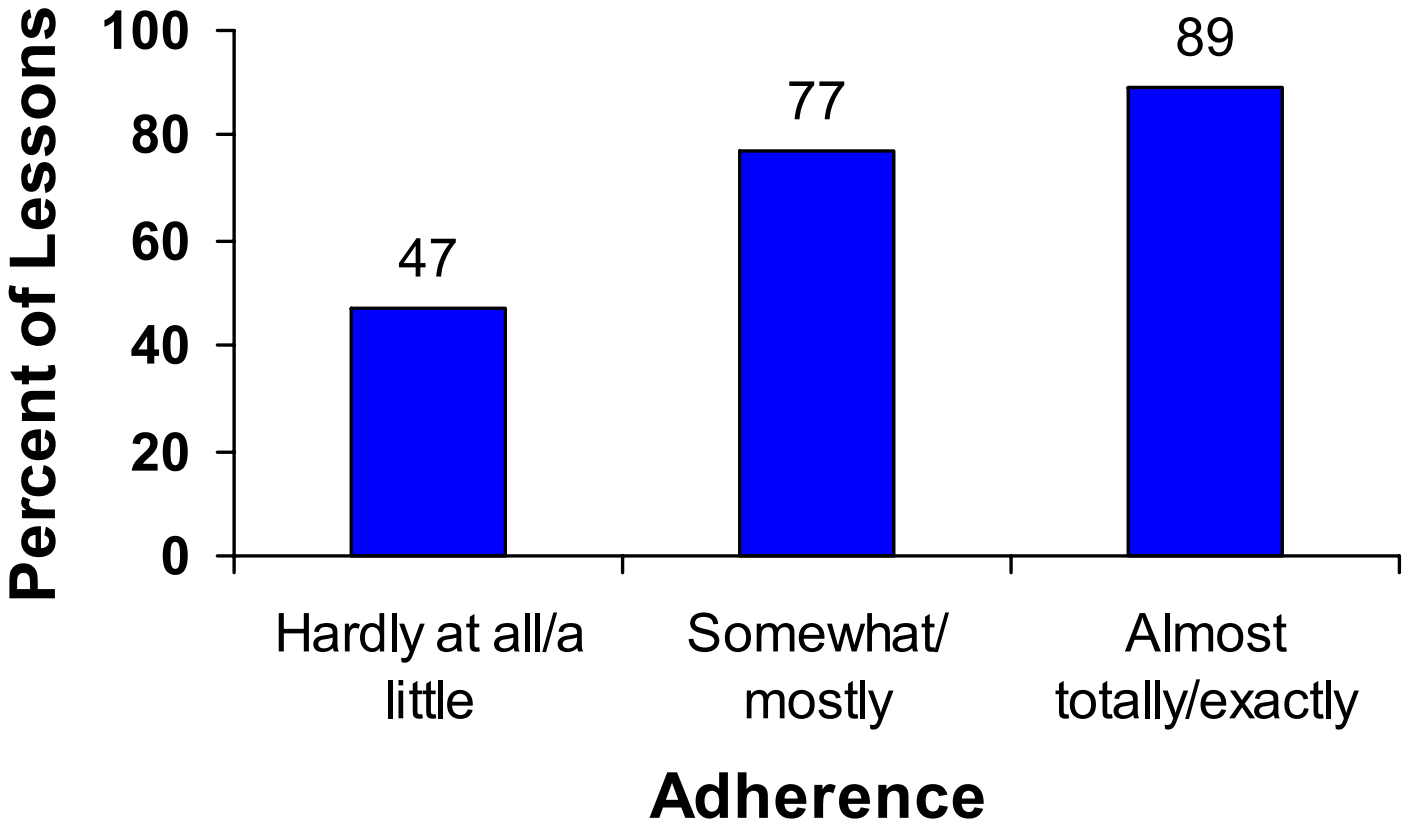
- More frequent use of investigative practices, questioning, and sense-making practices
- A greater likelihood that the classroom culture promoted intellectual rigor and student engagement

Based on classroom observations

Impact on Classroom Practices



Highly-Rated Lessons, by Adherence to LSC-Designated Materials



PIs were encouraged to visit classrooms, and reported that teachers were doing the activities without adequate focus on the mathematics.

Theoretical limitation: PIs evaluating their own "work" so they might be biased in a positive direction.

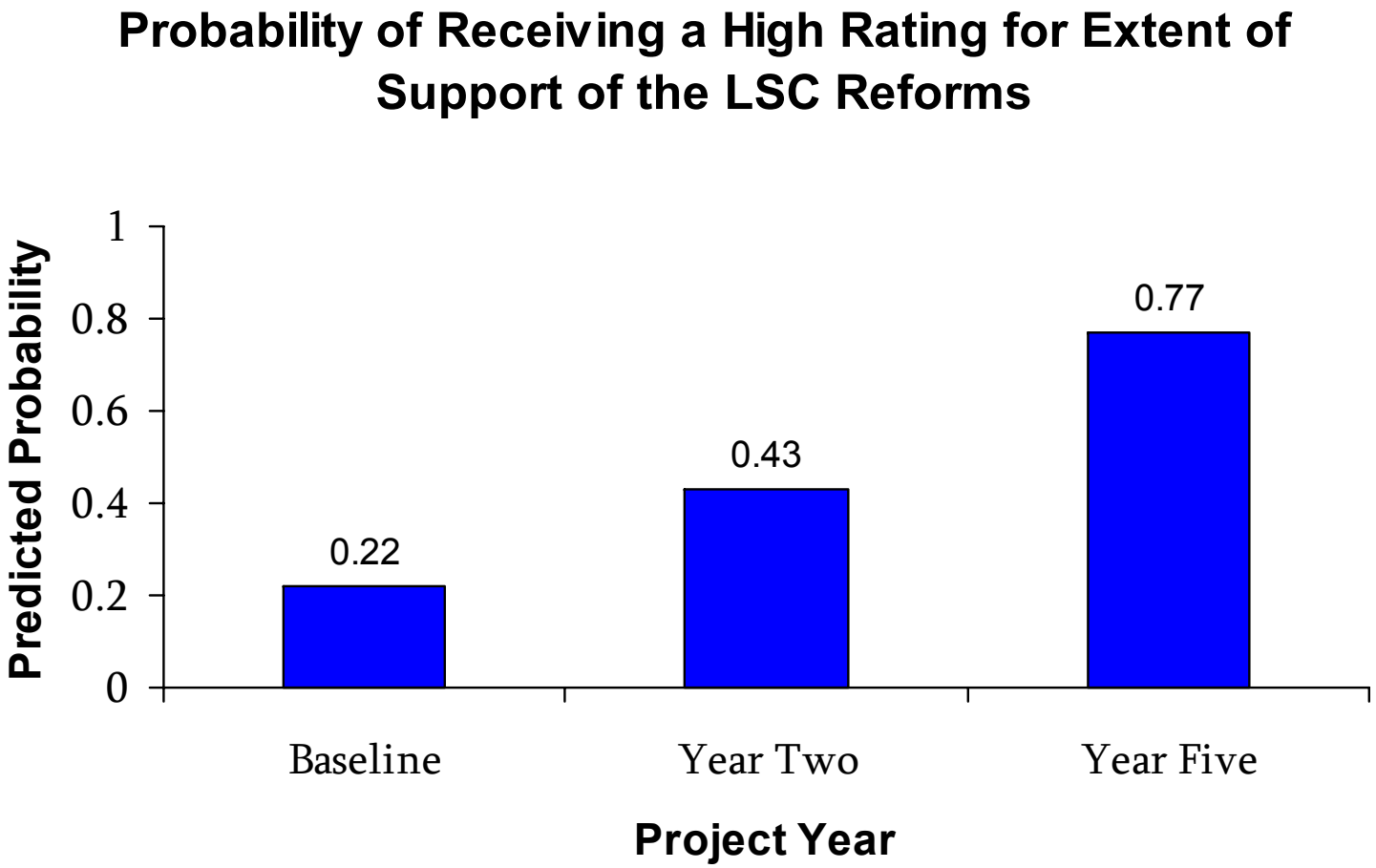
PI Report: Elementary Mathematics Class

"We could not see any evidence that she [the teacher] understood how the content in the lesson fit into the big picture of the unit. … She asked questions and her behavior indicated that she was cognizant of student thinking. However we did not see any evidence of a focus on student conceptual development."

PI Report: Secondary Mathematics Class

"In all three lessons observed, teachers did not demonstrate that they understood the content or how the concepts in the lessons they were teaching fit into the concepts in the unit. They tended to zero in on the minutia of a particular lesson and apparently did not recognize how the lessons fit into the bigger picture of the unit."

Impact on Districts



Likelihood of Institutionalization of the LSC Reforms

	Percent of Projects (N = 61)
Level 1: Rubber Band Likely to Snap Back	0
Level 2: LSC Reforms Likely to Gradually Fade Away	2
Level 3: Minor Components Likely to Become Institutionalized	19
Level 4: Components Likely to Become Institutionalized	62
Level 5: Institutionalization of LSC Reforms Likely	17

Challenges in the LSC:

- Preparing and deploying professional development providers
- Reaching the goal of 130 hours over five years
- Teachers changing grades
- Teacher (and administrator) turnover

Aspects of instruction that needed additional improvement:

- Student intellectual engagement with important ideas relevant to the focus of the lesson
- Portraying mathematics as a dynamic body of knowledge continually enriched by conjecture, investigation, analysis, and proof/justification

- Adequate time and structure for “sense-making”
- Teachers’ questioning strategies
- Encouraging students to generate ideas, questions, conjectures, and propositions
- Including intellectual rigor, constructive criticism, and the challenging of ideas

Lessons Learned in the LSC:

- Need to involve principals earlier, and more often
- Need to make sure to keep a focus on mathematics content – what is the mathematical pay-off for particular activities?
- Need to go into classrooms to see what is actually happening
- Evaluation instruments/procedures can be repurposed to help convey the vision for teaching and learning, as well as for aligned policy in support of that vision

Scaling up effective professional development is not enough; need to think about going to scale with reforms.

Elmore, R.F. (1996). Getting to scale with good educational practice. *Harvard Education Review 66*(1), 1-26.

Statewide Systemic Initiatives (SSIs)

In the 1990's, 26 awards of up to 10 million over 5 years (and some had a second phase) for statewide reform of mathematics and science education

- Horizon Research, Inc. and Education Development Center developed a Handbook for Enhancing Strategic Leadership in the Math and Science Partnerships

- Article based on this work by Weiss and Miller in a recent NCSM monograph

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Lessons Learned About:

- Designing and Implementing Interventions
- Garnering Support from Key Stakeholders
- Aligning Policy
- Scaling Up Interventions

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Designing and Implementing Interventions

- Understand the nature and extent of needs in your context
- Select effective, promising intervention approaches
- Pilot the interventions to get the “kinks” out and demonstrate their effectiveness
- Make sure the mathematics doesn’t get lost

Garnering Support from Key Stakeholders

- Identify the key stakeholders
- Build support for the overall reform vision, not just for specific interventions
- Leverage the support of influential stakeholders

Aligning Policy

- Identify the most influential policies and have a plan for dealing with them
- Leverage aligned policies to move forward
- Seek and create opportunities to align policies

Scaling Up Interventions

- Develop human resources
- Develop infrastructure
- Create a system for maintaining quality

Math/Science Partnerships

Comprehensive, Targeted, and Institute projects were funded by NSF

State MSP's are being funded by the Department of Education

Hallmark of MSPs is involvement of STEM faculty in K-12 reform

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Too early to have “findings,” but should provide lessons for effective district partnerships with higher education, particularly STEM faculty

If a university wants you as a partner…

Use your leverage. Have a master plan, and make sure the work fits into it.

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If you get external funds, e.g., a state MSP, don't just make hay while the sun shines. Think about 10 years out, and what you can do with the external money that will create lasting capacity and infrastructure.

You don’t need external funds to improve mathematics education in your district. Think big, but start small; take advantage of opportunities to align policies and practices; and keep moving forward.