



Effective Professional Development in Science:

Why Do We Need It? What Does It Look Like?

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Overview

- Making the case for professional development
 - Observation studies
 - Teacher surveys
- A vision of effective professional development




Part I

Making the Case for Professional Development

Data Sources

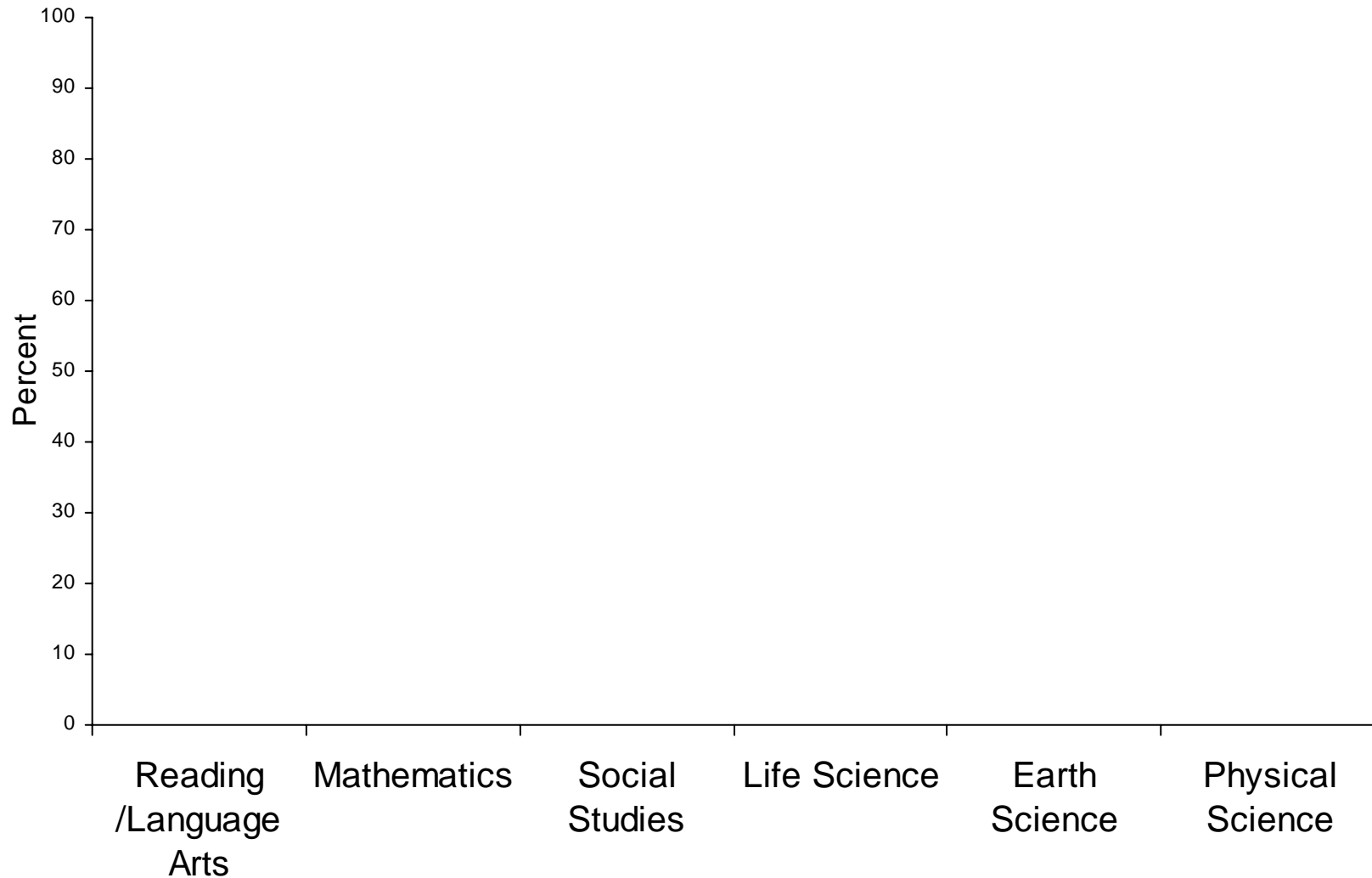
- 2000 National Survey of Science and Mathematics Education
- Looking Inside the Classroom (2001)
- Cross-site evaluation of the Local Systemic Change Initiatives (1996 to present)



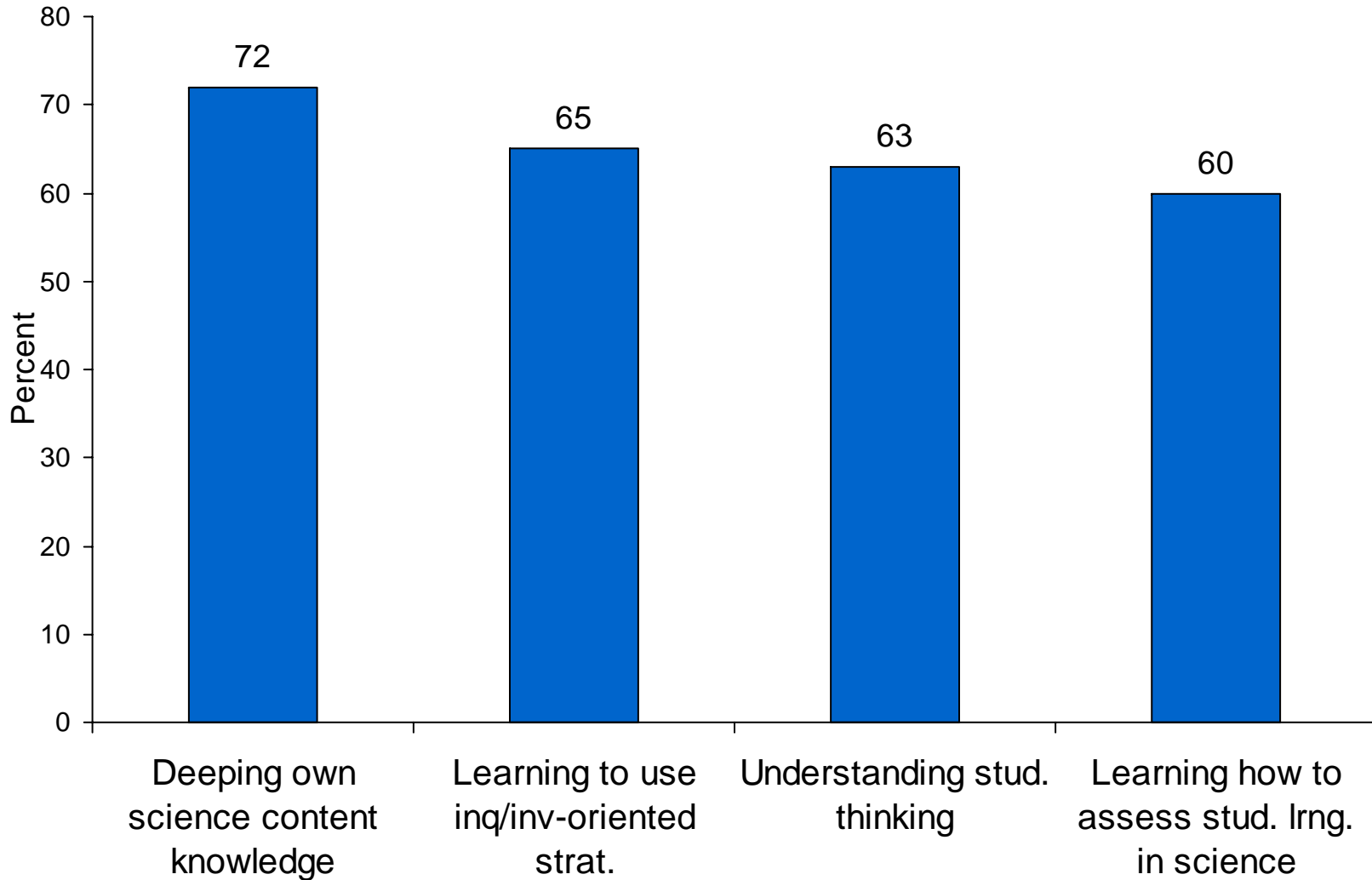
2000 National Survey of Science and Mathematics Education

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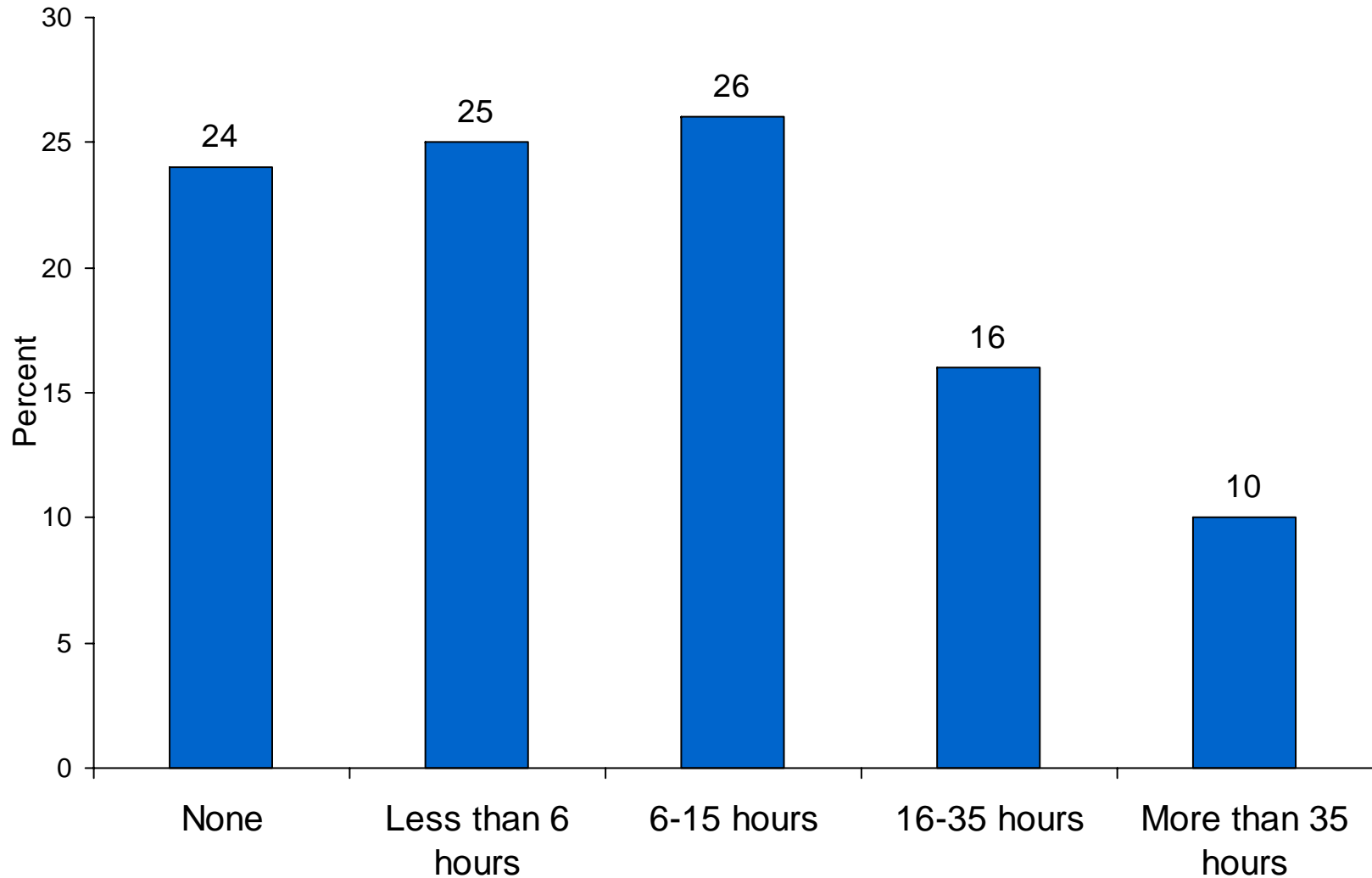
K-5 Self-Contained Teachers Considering Themselves Very Well Qualified to Teach Each Subject



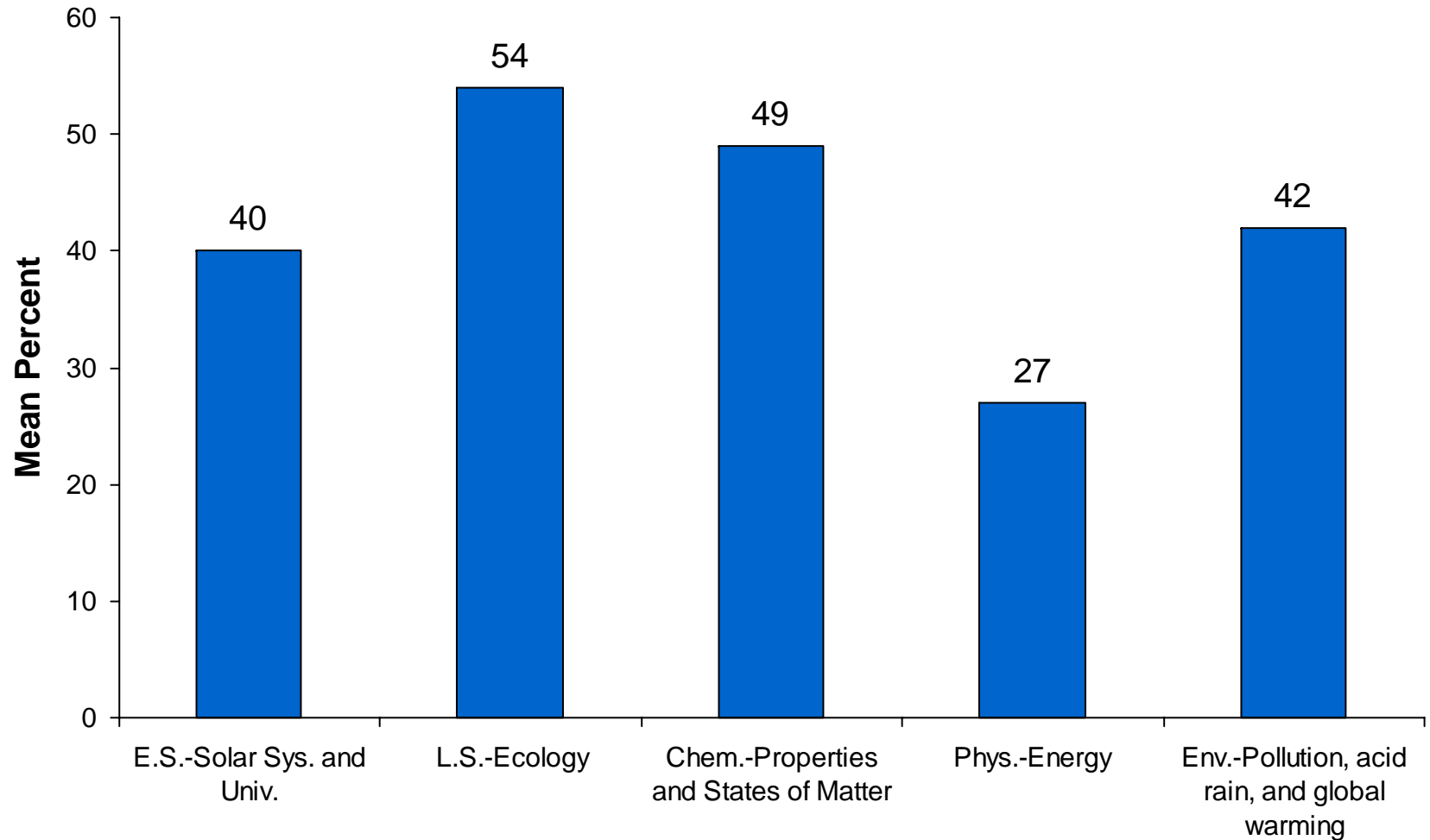
K-5 Self-Contained Teachers Expressing Moderate or Substantial Need for Professional Development



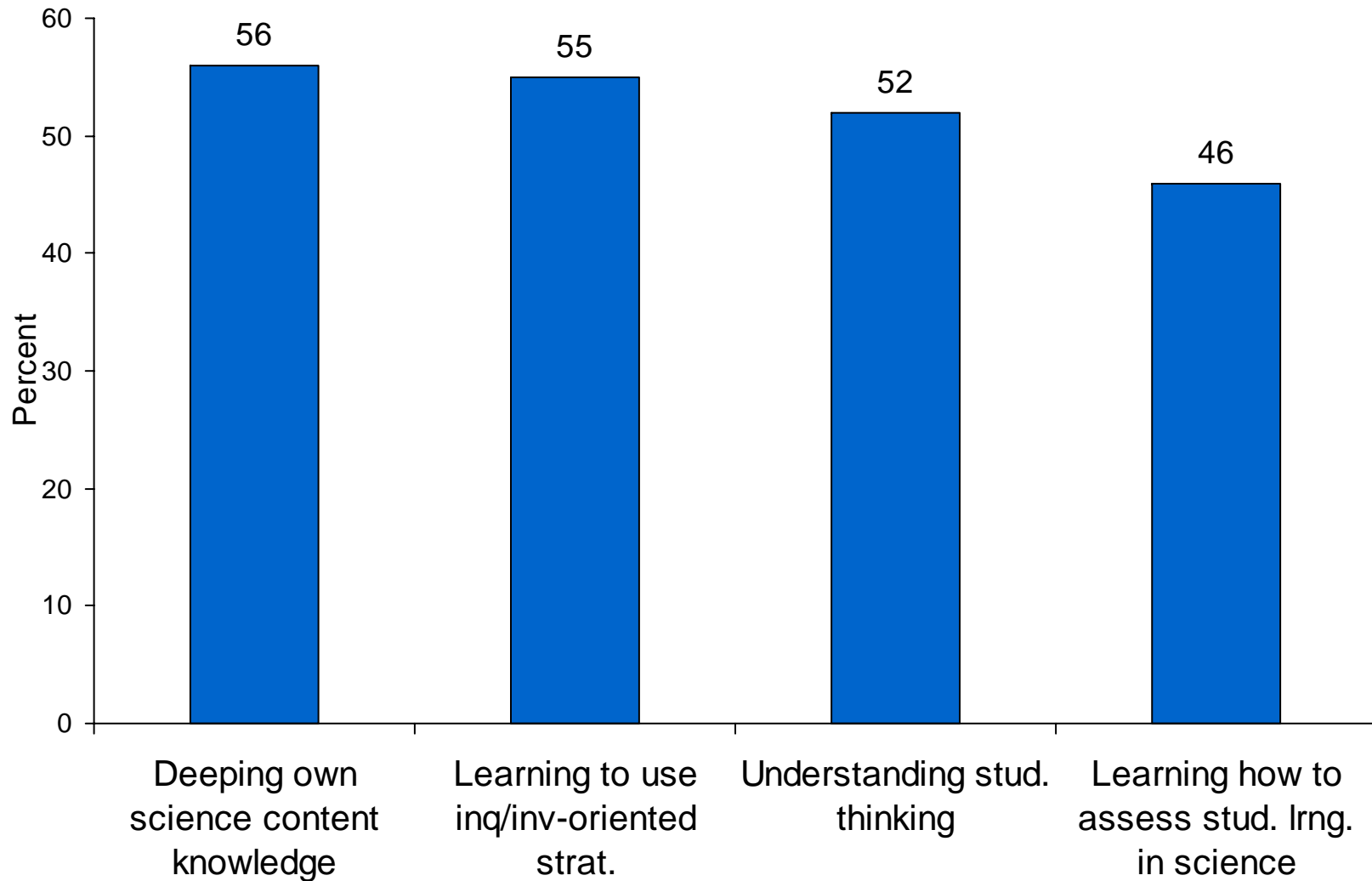
K-5 Self-Contained Teachers' Hours of Science-related PD in Preceding Three Years



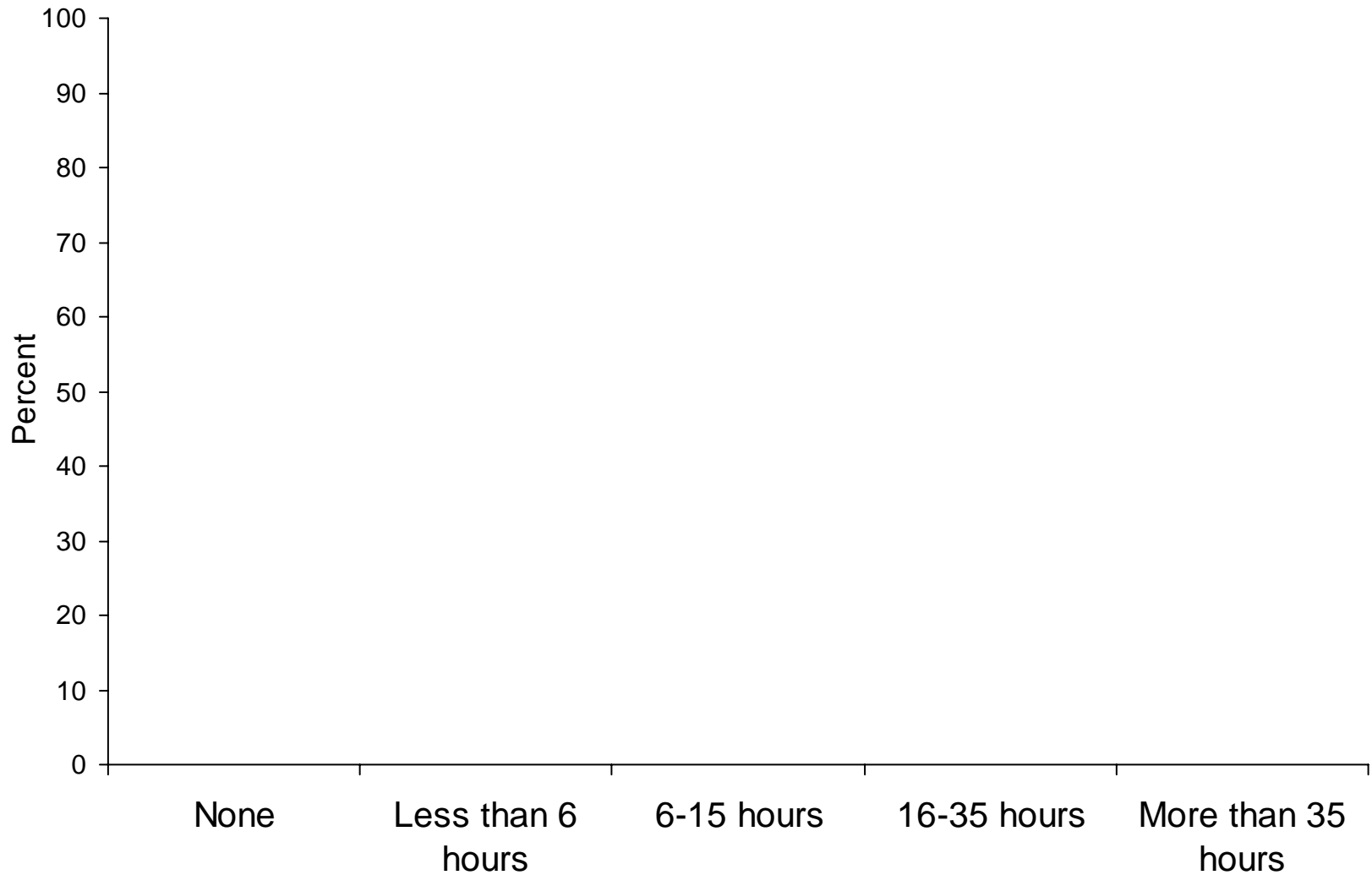
Middle School Science Teachers Considering Themselves Very Well Qualified to Teach Each Subject



Middle School Science Teachers Expressing Moderate or Substantial Need for Professional Development



Middle School Science Teachers' Hours of Science-related PD in Preceding Three Years




Looking Inside the Classroom

- Observed a nationally representative sample of 364 K-12 science and mathematics lessons
- 30 school districts around the nation
- Lessons equally divided among K-5, 6-8, and 9-12; divided equally between science and mathematics.

Among the Questions Addressed by *Inside The Classroom:*

1. How does science instruction “look” in the nation’s classrooms?
2. Are students actively engaged in pursuing questions of interest to them?
3. Do lessons engage students intellectually with important science content?
4. Is teacher-presented information accurate?
5. Are teachers’ questions likely to develop conceptual understanding?
6. Are adequate time and structure provided for reflection and sense-making?

7. Is there a climate of respect for students' ideas and questions? Are students encouraged to generate ideas and questions?
8. To what extent does each of the following factors shape teachers' decisions about curriculum and pedagogy:
 - Teacher beliefs about how students learn;
 - Student characteristics;
 - School and district administration; and
 - School, district, and state policies regarding curriculum, textbook adoption, testing, and professional development.

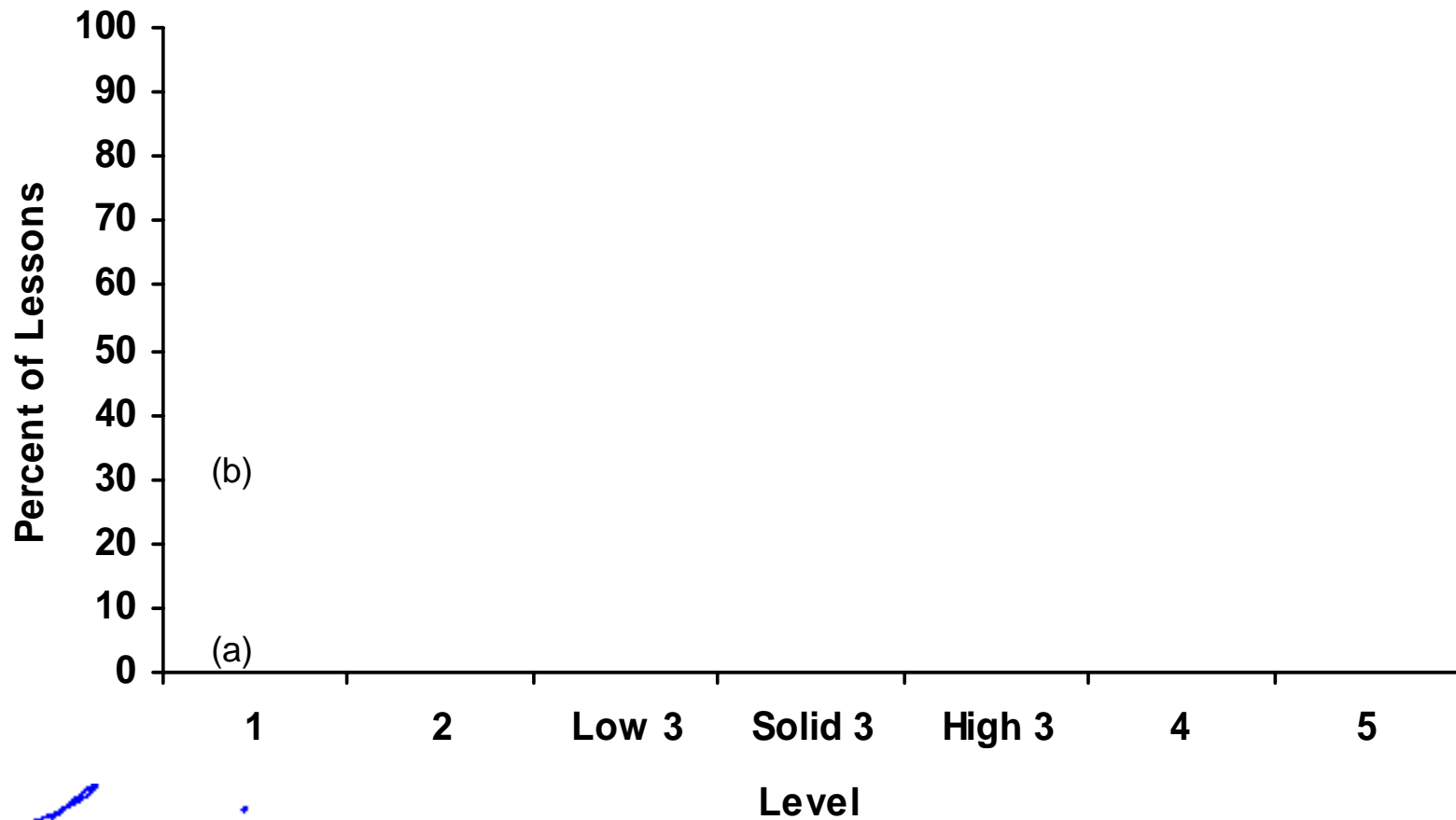


What percent of science lessons nationally are “high quality”?

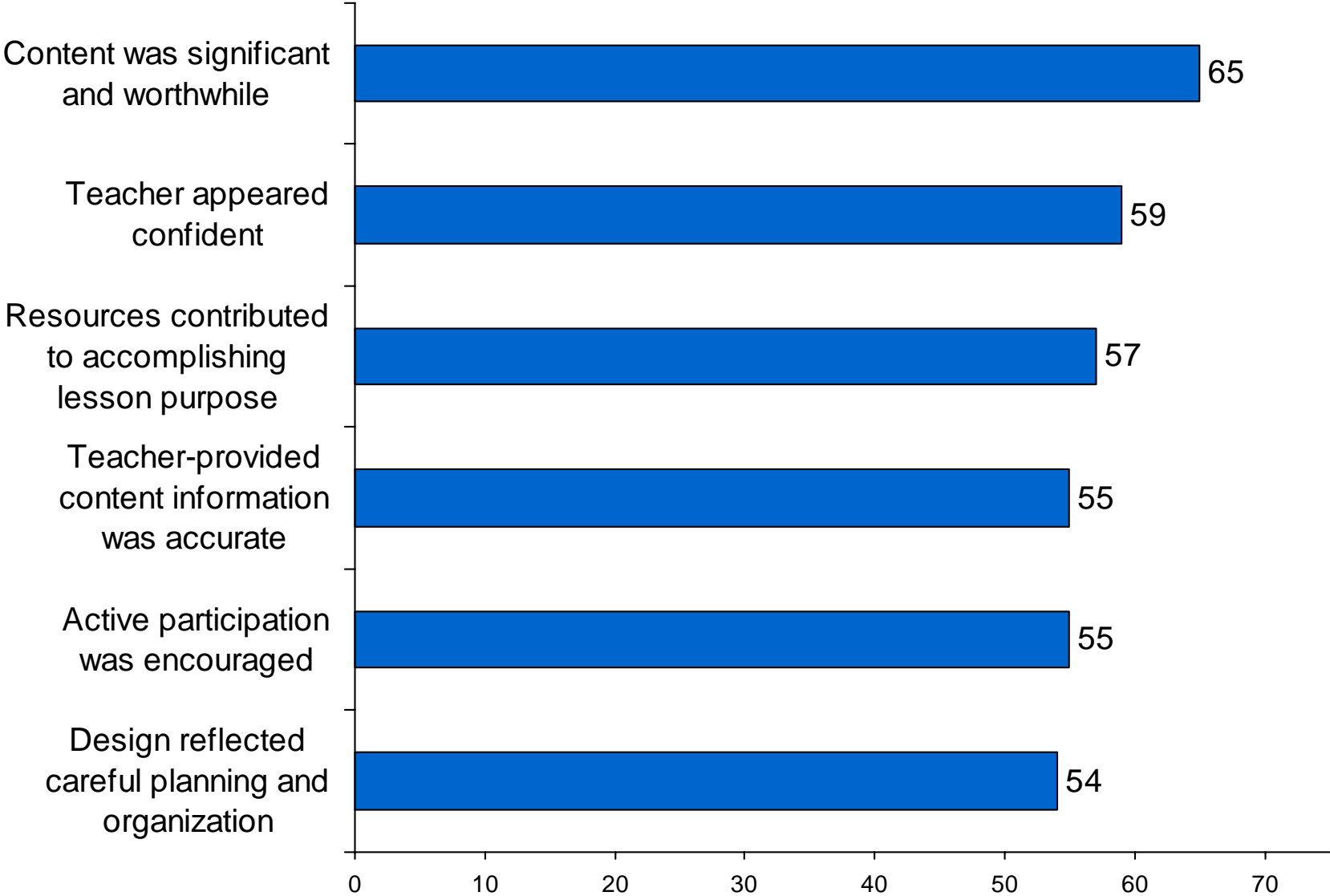
Overall Lesson Rating Scale

- Level 1: Ineffective instruction
- a. "passive learning"
 - b. "activity for activity's sake"
- Level 2: Elements of effective instruction
- Level 3: Beginning stages of effective instruction
(low, solid, high)
- Level 4: Accomplished, effective instruction
- Level 5: Exemplary instruction

Overall Ratings: K-8 Science Lessons

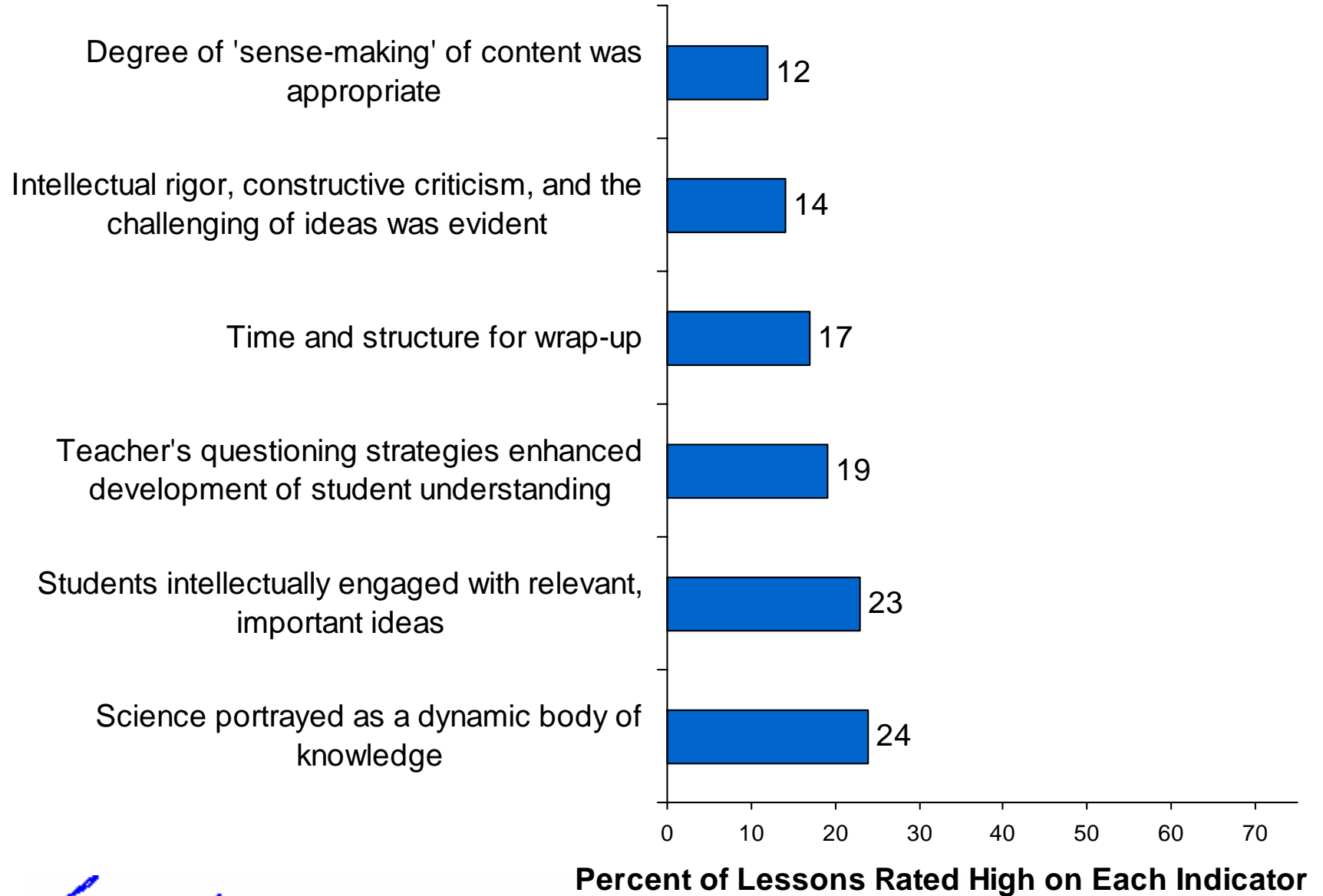


K-8 Science: Relative Strengths



Percent of Lessons Rated High on Each Indicator

K-8 Science: Major Weaknesses



Key Elements of High Quality Instruction

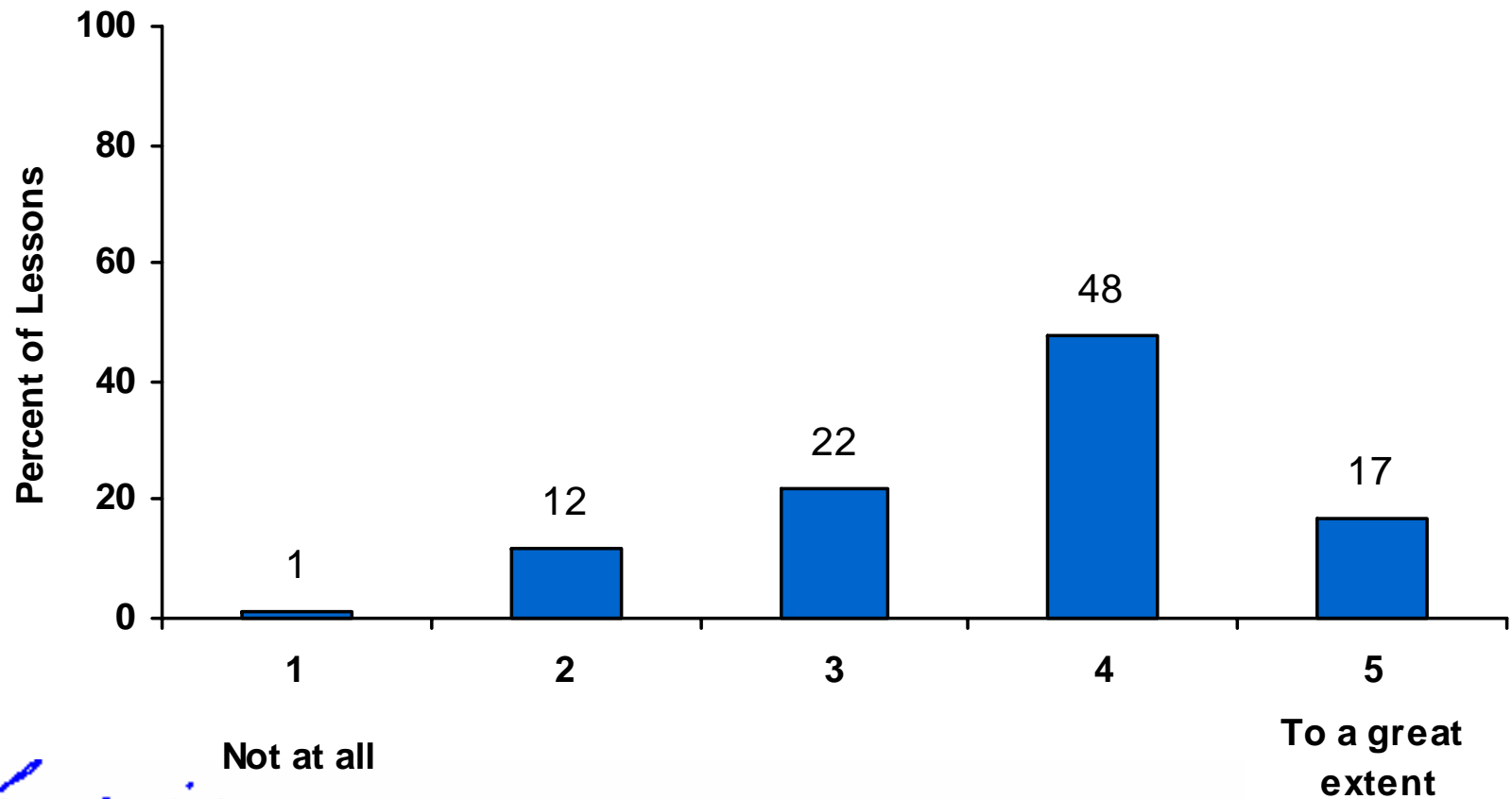
- Engage students with the science content;
- Create an environment conducive to learning;
- Ensure access for all students;
- Use questioning to monitor and promote understanding; and
- Help students make sense of the science content.



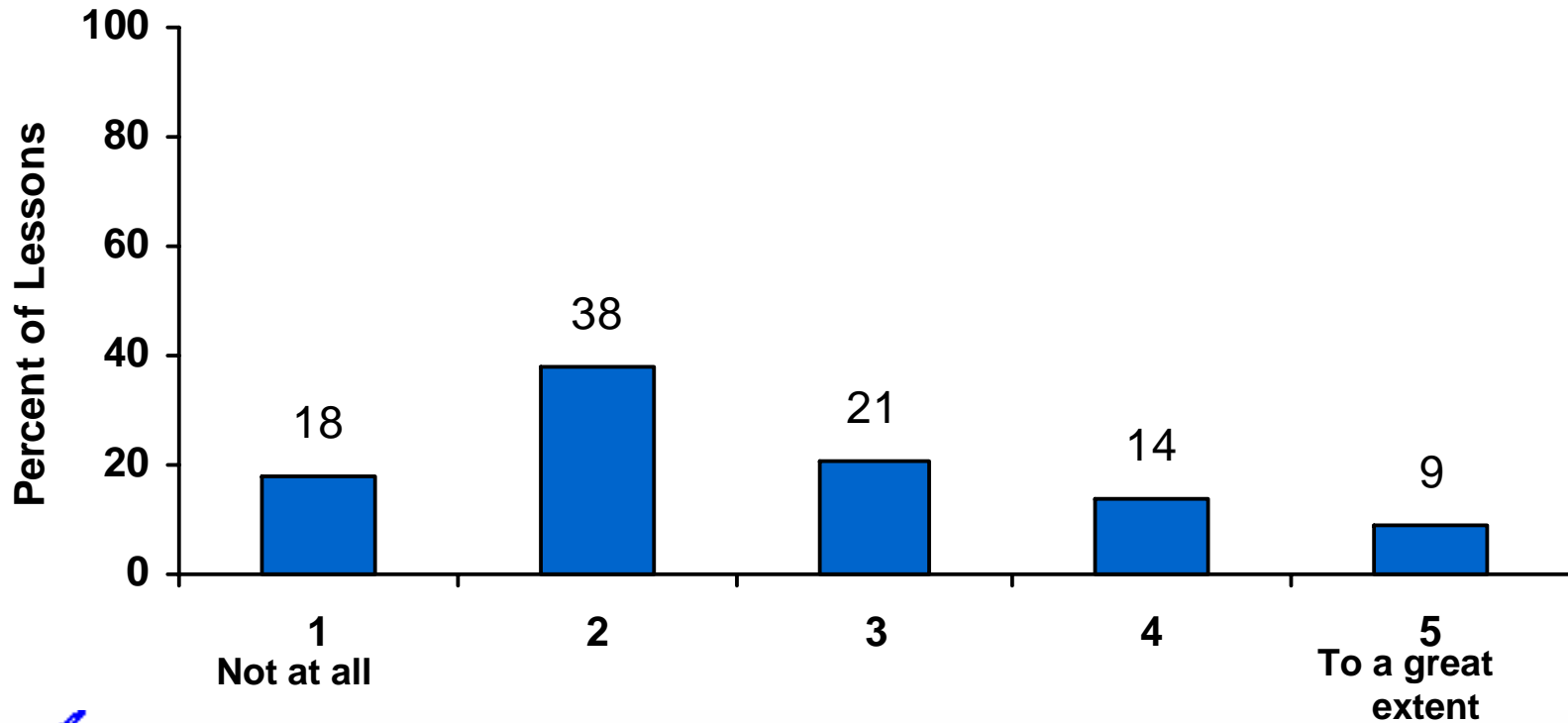
Engaging Students With Science Content

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Science Content Is Significant and Worthwhile: K-8 Science



Students Are Intellectually Engaged with Important Ideas Relevant to the Focus of the Lesson: K-8 Science



Many Lessons “Just Started”

- Turn to page 117 in your textbook
- We’re at IV.B. 2a in your lecture notes outline
- Today we’re doing activity 12; get your materials and begin working in your table groups.

In Contrast:

- As an introduction to the relationship between form and function in living things, the teacher in a 4th grade science class handed out a tail feather and a magnifying glass to each pair of students, and asked them to examine the feather, pull the barbs apart, and look for the hooks. They then pulled the feather between their fingers, making the barbs stick back together. The teacher then handed out a down feather and they repeated their investigations.

Portraying Science as a Dynamic Body of Knowledge

An 8th grade science lesson was designed to give the students a great deal of factual information on Newton's Third Law of Motion. The students copied notes from the blackboard for half of the lesson, and the next half of the lesson was spent with the teacher asking them to recall information from the notes.

In Contrast:

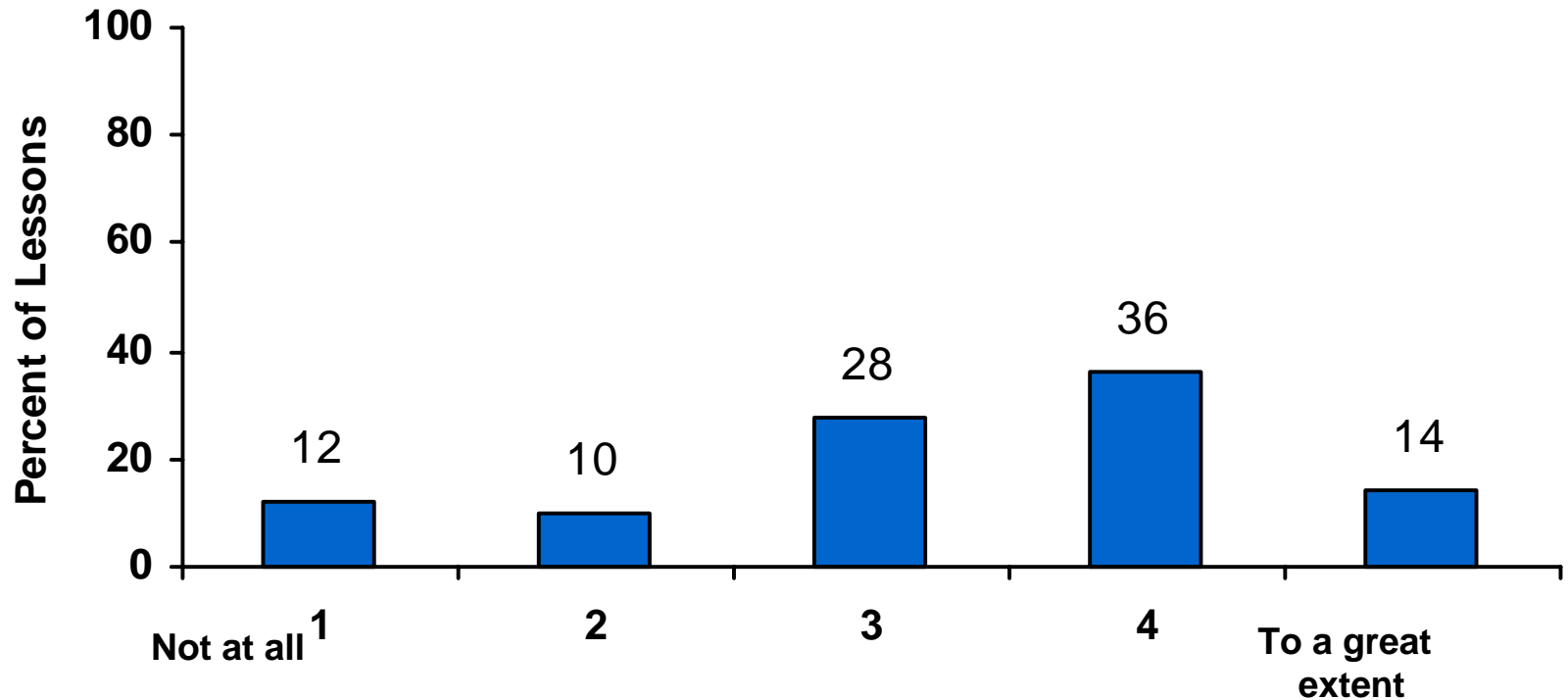
A 6th grade science lesson consisted of a teacher-led discussion of the process of sedimentary rock formation. By drawing upon the experiences and prior knowledge of the students, the teacher helped the students devise a model of how sedimentary rock is formed. For example, the teacher asked students, if they broke a vase, what they would need to fix it. The students decided that not only would they need glue, they would also need something to push the pieces together. The teacher then asked the students, "Where might the force come from [to push sand together to make sandstone]?" The teacher probed students until they considered possible sources of the pressure. This lesson emulated the scientific process of using observable data and knowledge of basic scientific principles to create a model of an unobservable process.



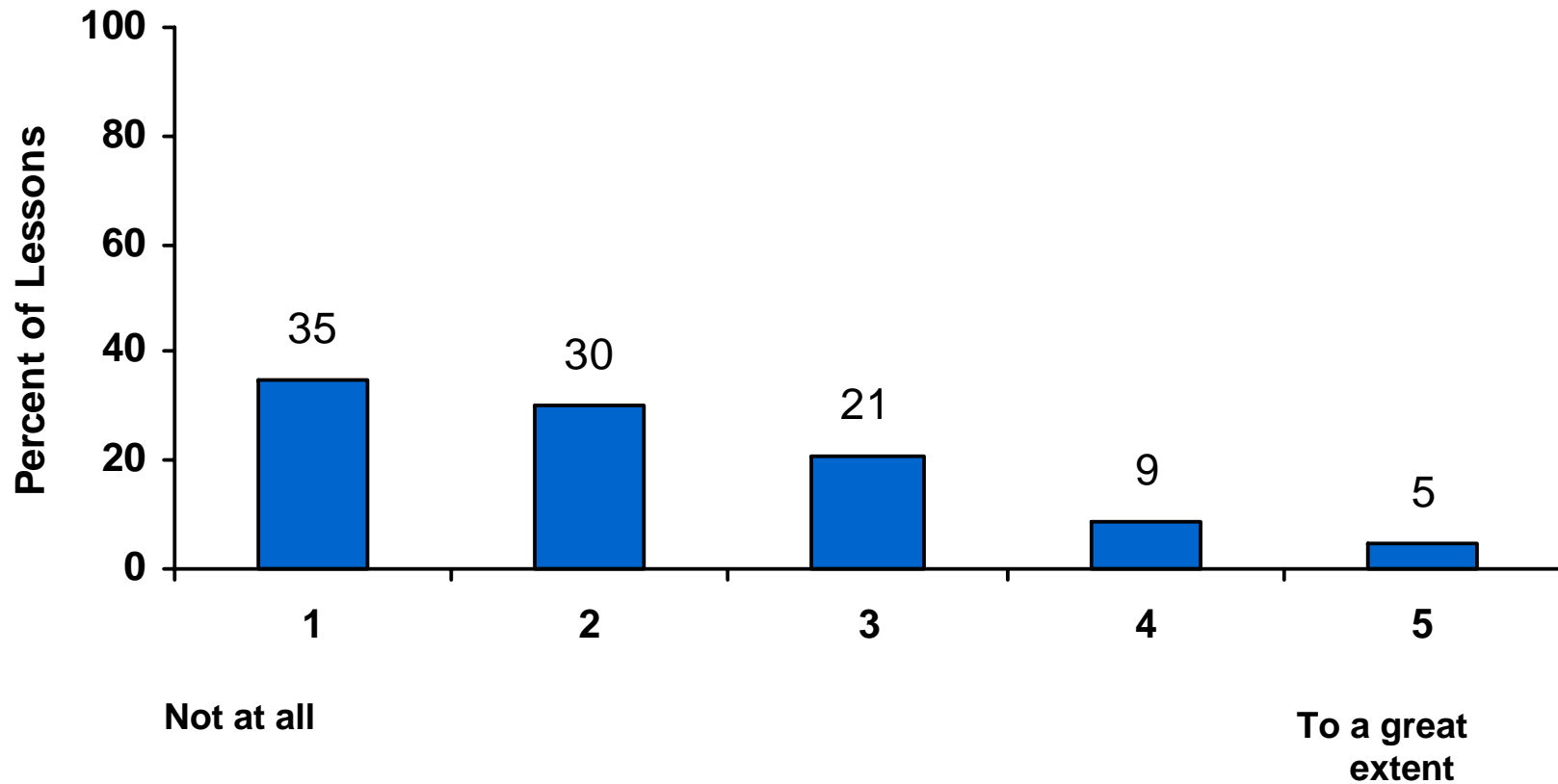
Creating an Environment Conducive to Learning

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Climate of Respect for Students' Ideas, Questions, and Contributions: K-8 Science



Intellectual Rigor, Constructive Criticism, and Challenging of Ideas Are Evident: K-8 Science



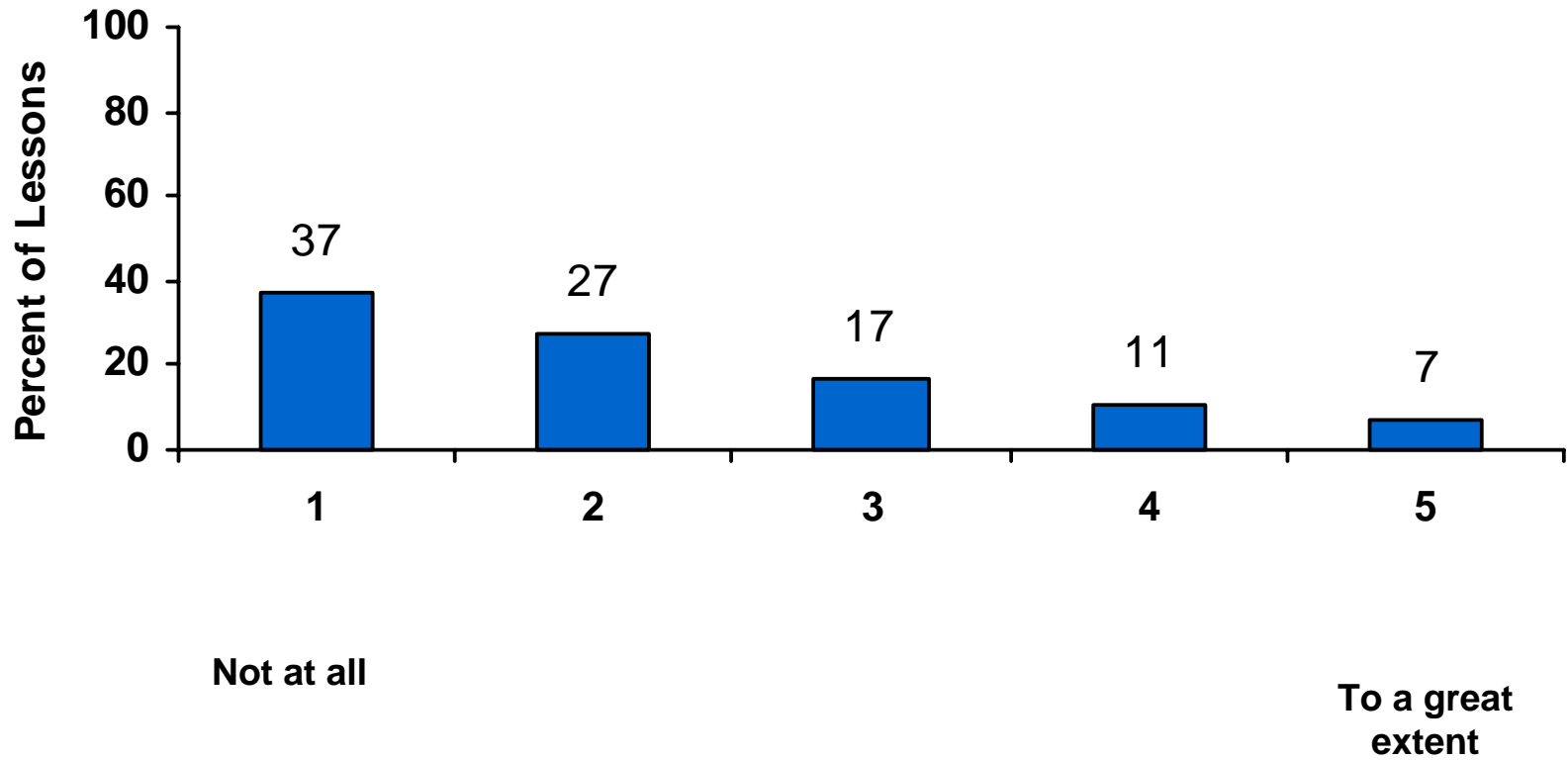
Cross Tabulation of Climate of Respect and Intellectual Rigor

		Percent of Lessons		
		Intellectual Rigor		
		Low	Medium	High
Climate of Respect	Low	26	1	0
	Medium	24	3	1
	High	17	14	13




Questioning to Encourage Students to Think More Deeply

Teacher's Questioning Enhanced Development of Student Understanding/Problem Solving: K-8 Science



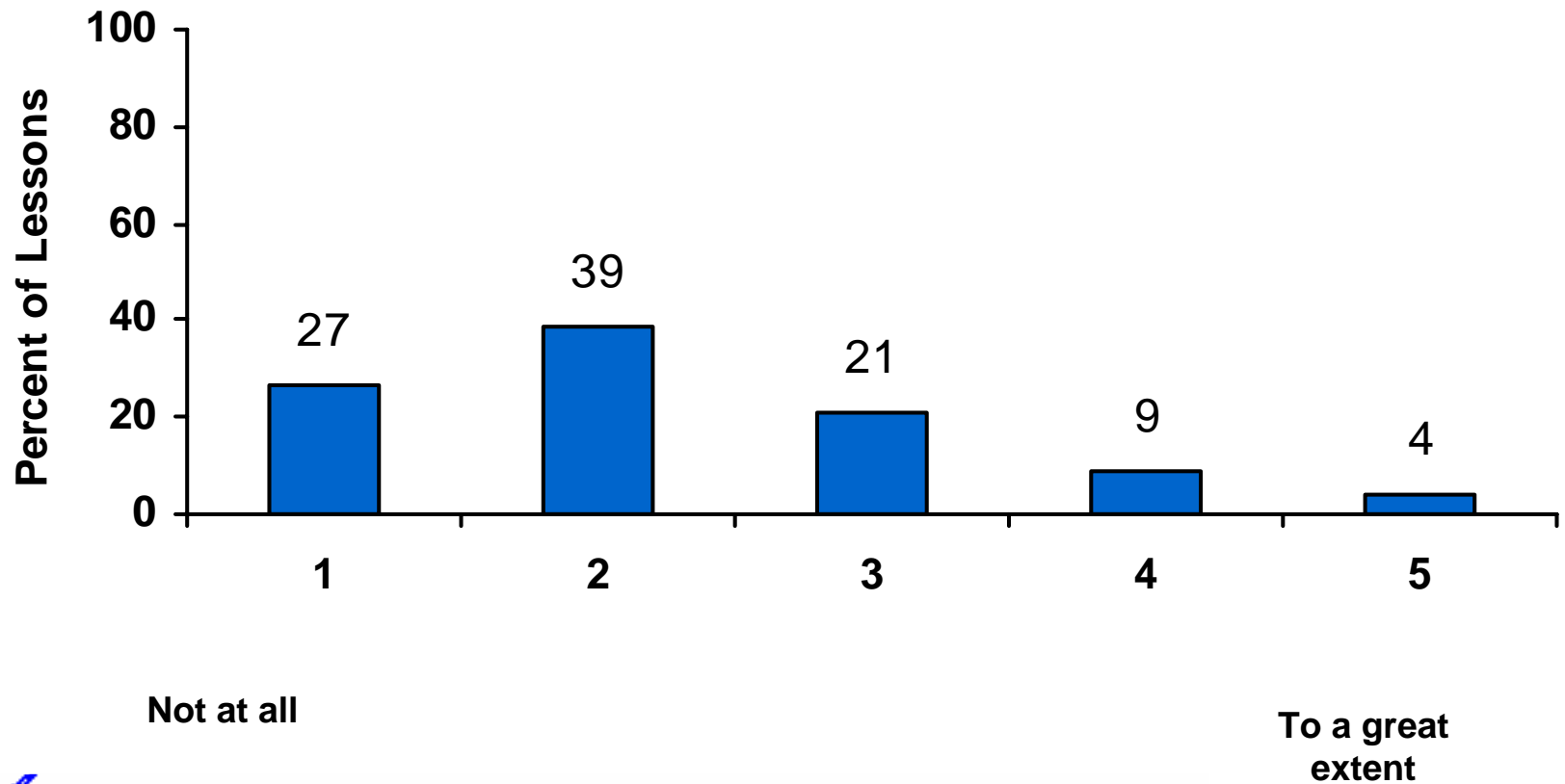
How would you rate the following question-and-answer session that took place in a 6th grade science lesson on weather and the atmosphere?

- Teacher: “The first layer is the what?”
- Students: “Troposphere”
- Teacher: “How many layers are there?”
- Students: “Four”
- Teacher: “What happens in the troposphere?”
- Student: “It rains”
- Teacher: “What happens in that layer?”
- [Students unsure]
- Teacher: “w, w, w...”
- Student: “Water?”
- Teacher: “What have we been studying?”
- Student: “Weather.”
- Teacher: “What are four forms of precipitation?”
- Students: “Rain, snow, sleet, hail”



Inadequate attention to “sense-making”

Degree of Sense-Making Is Appropriate for This Lesson: K-8 Science



3rd Grade Science Lesson

The teacher guided a 3rd grade class through the completion of a science worksheet by referring the students to a particular question, telling them to turn to a specific page in their textbook and look for the answer, asking one student volunteer to read the answer from the book, then writing the answer on an overhead transparency copy of their worksheet. The observer reported the following conversation as an example:

Teacher: "Let's look at lesson two. Turn to page E16. Fill in the blank. Look on the page. Matter is made of...what?"

Student 1: "Atoms."

Teacher: "Adding heat changes a solid to a what?"

Student 2: "Liquid."

Teacher: "Good. Now read number three."

At the completion of the worksheet, the teacher then went over the questions and answers to summarize the content in the lesson. The students were instructed to keep their worksheets for the next lesson.

Lessons Learned from Looking Inside the Classroom

- Choice of instructional strategy doesn't appear to be as important as some have suggested.
- The key appears to be first providing students an opportunity to engage with important science concepts and then ensuring that they in fact make sense of these concepts.



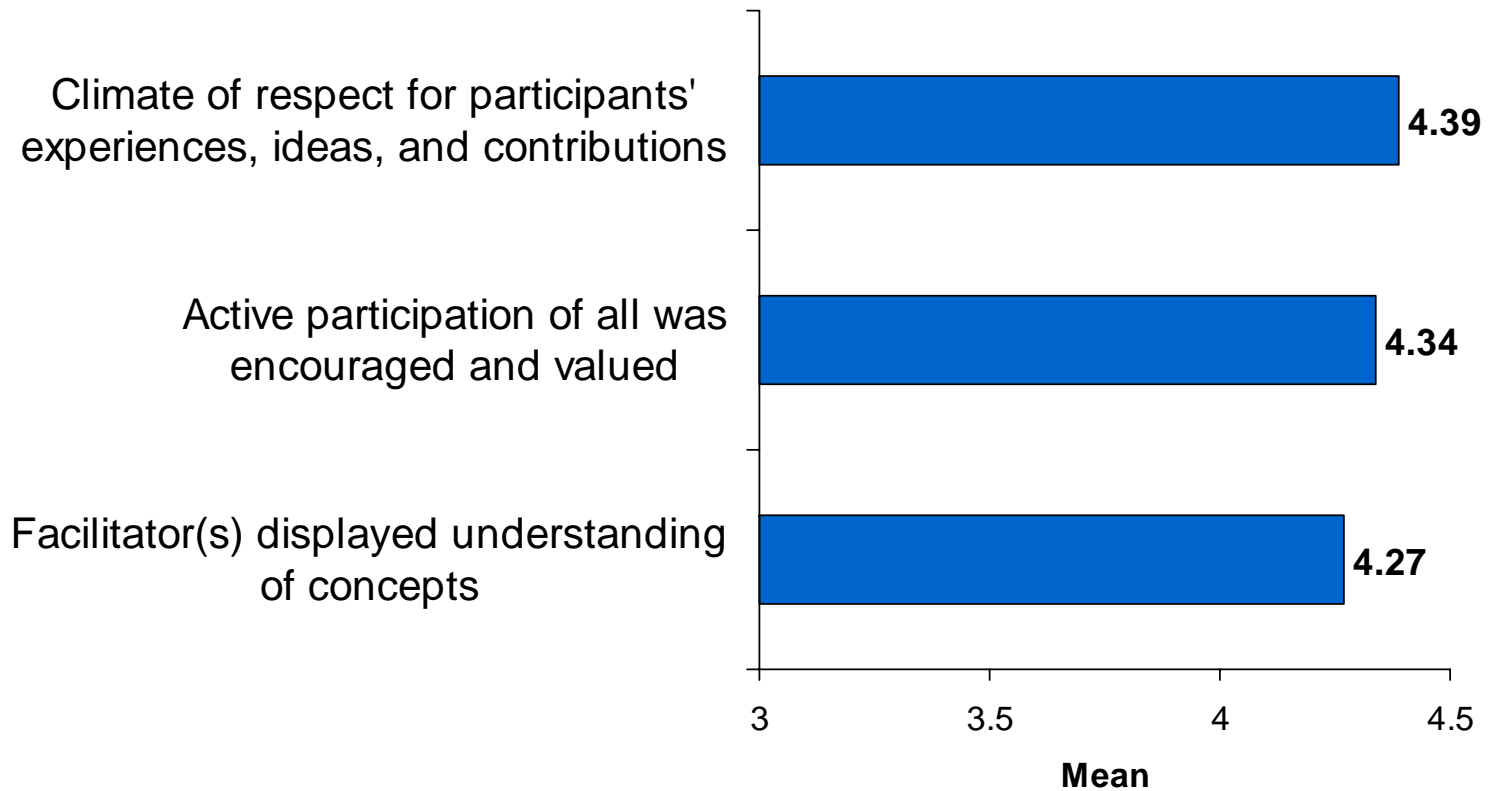
Cross-site Evaluation of Local Systemic Change (LSC) Projects

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Local Systemic Change (LSC) Projects

- Professional development on designated instructional materials
- 130 hours of professional development
- Target all teachers, not just volunteers

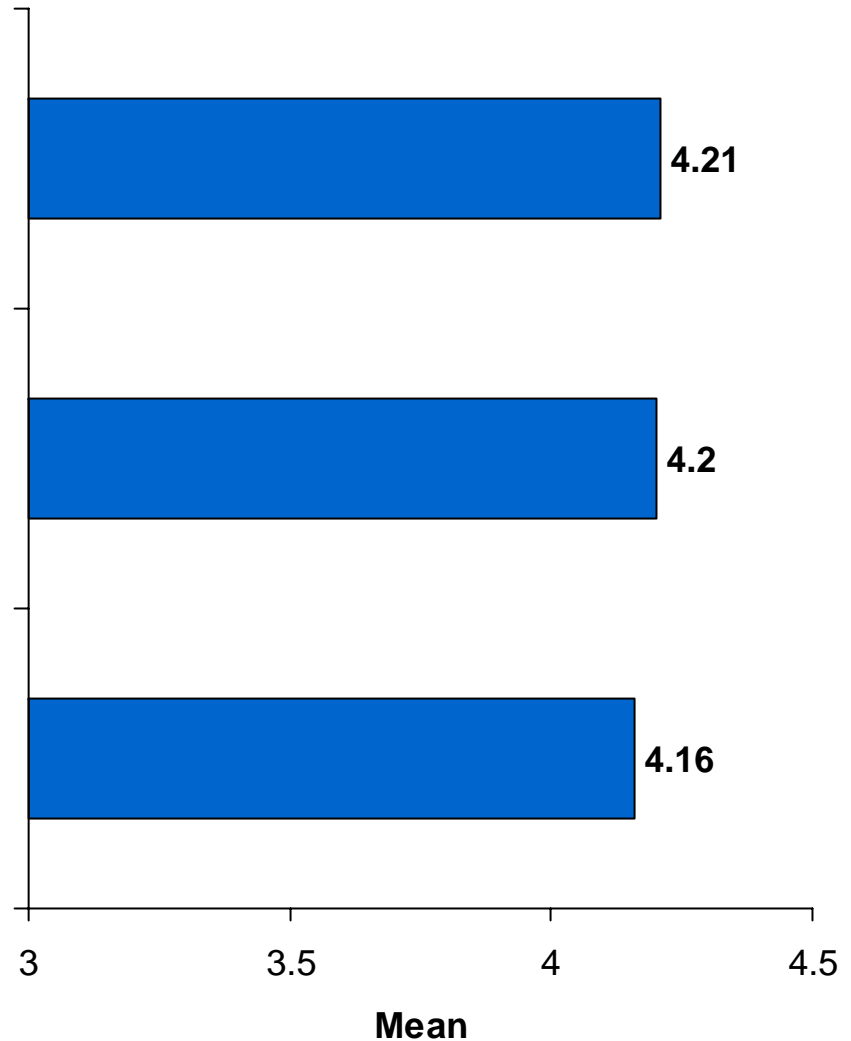
Relative Strengths of the LSC Professional Development



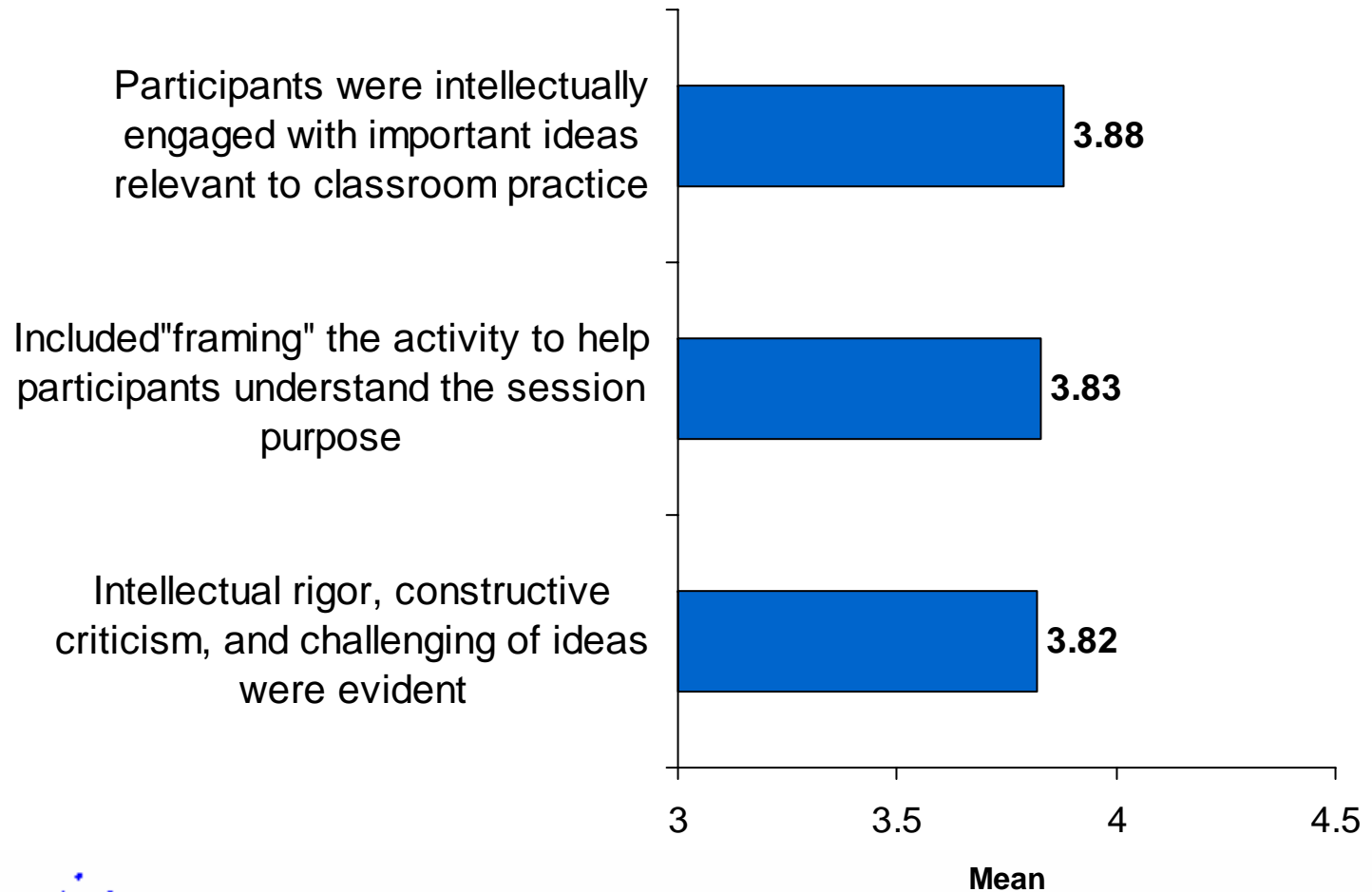
Facilitator(s)' background,
experience, and/or expertise
enhanced the quality of the session

Content appropriate for purposes of
session and participants'
background

Encouraged a collaborative
approach to learning



Relative Weaknesses of the LSC Professional Development



Attention to student thinking/learning was appropriate for the session's purpose and participants' needs

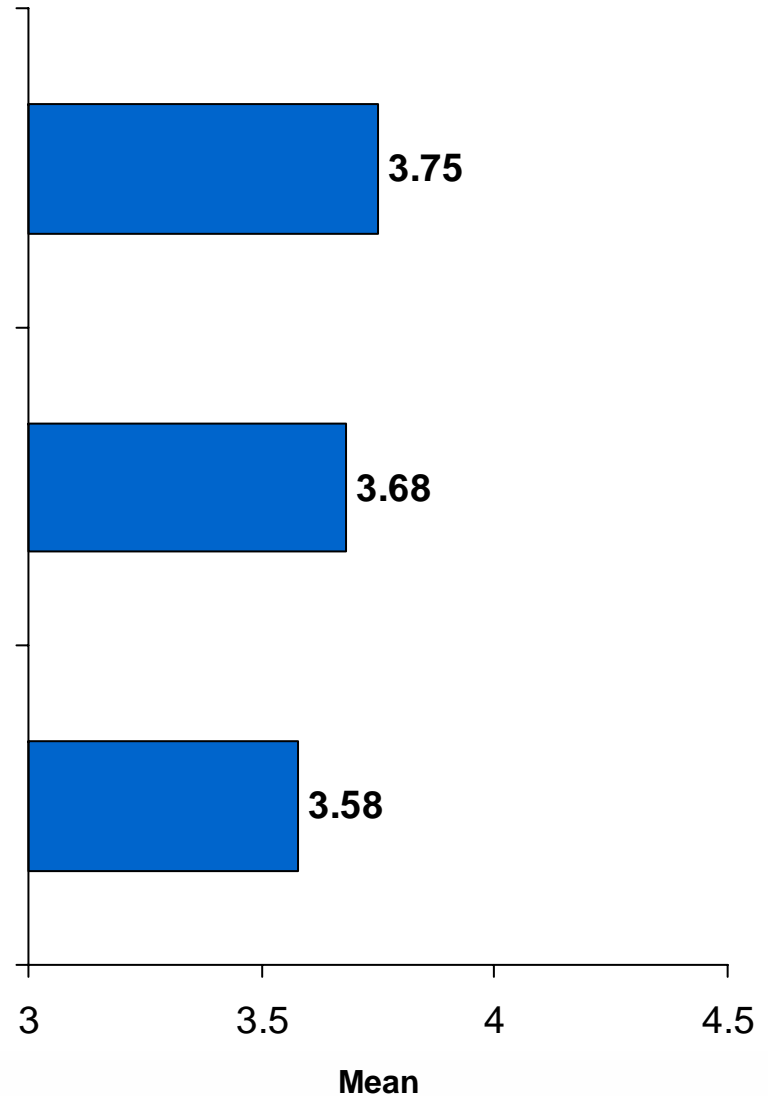
3.75

Adequate time and structure provided for 'sense-making'

3.68

Extent of 'sense-making' about classroom practice was appropriate for session's purpose and adult learners' needs

3.58



Extent of "sense-making" of content was appropriate for session purpose and adult learners' needs

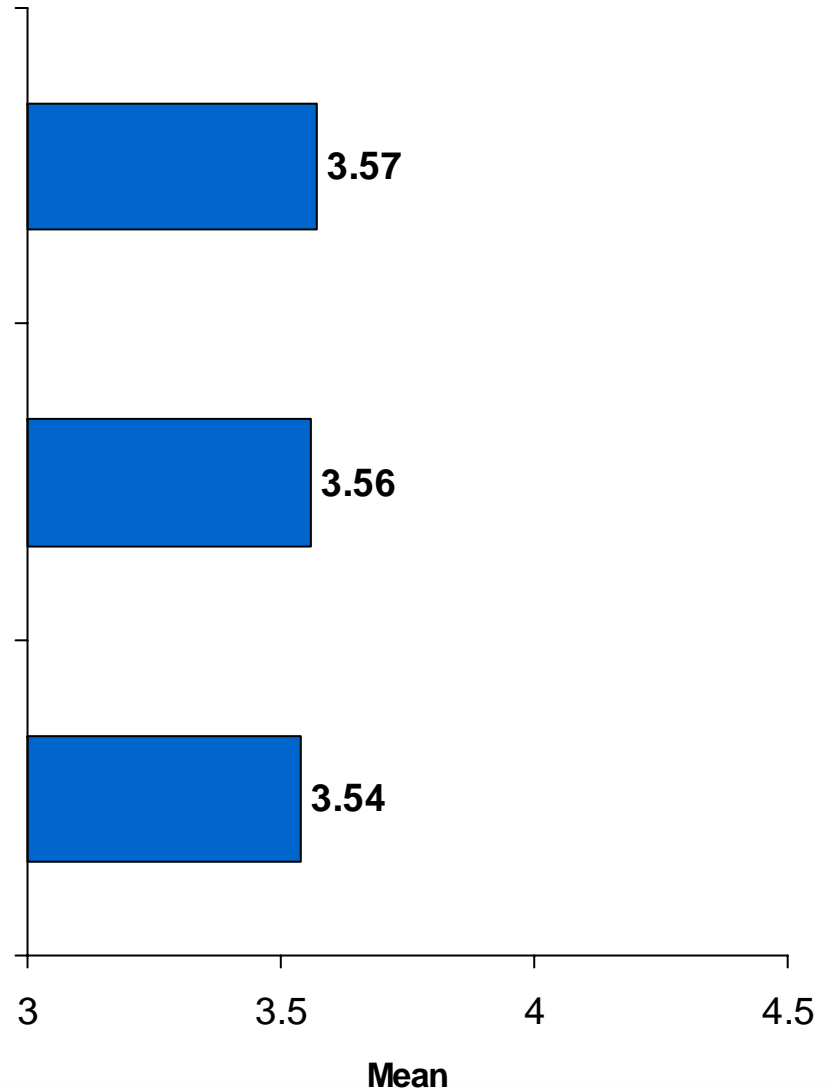
3.57


Facilitator(s) effectively modeled questioning strategies

3.56

Adequate time and structure were provided for wrap-up

3.54





Note the similarities in
strengths and weaknesses of
professional development and
classroom instruction

When we go into classrooms: how deep are changes in practice?

- Lessons taught by teachers using standards-based instructional materials, with PD on those materials, incorporated some specific strategies from PD.
- But PIs reported that even these lessons typically fell short of the vision on areas such as the use of higher order questioning and making sense of data.

(Pasley, 2002)

"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 minutiae of a particular lesson and apparently did not recognize how the lessons fit into the bigger picture of the unit.

The issues demonstrated in the observations are difficult to address within the format of the professional development program. Teachers need to change their perceptions of themselves as teachers, their own ideas of learning, and their understanding of how students learn mathematics."

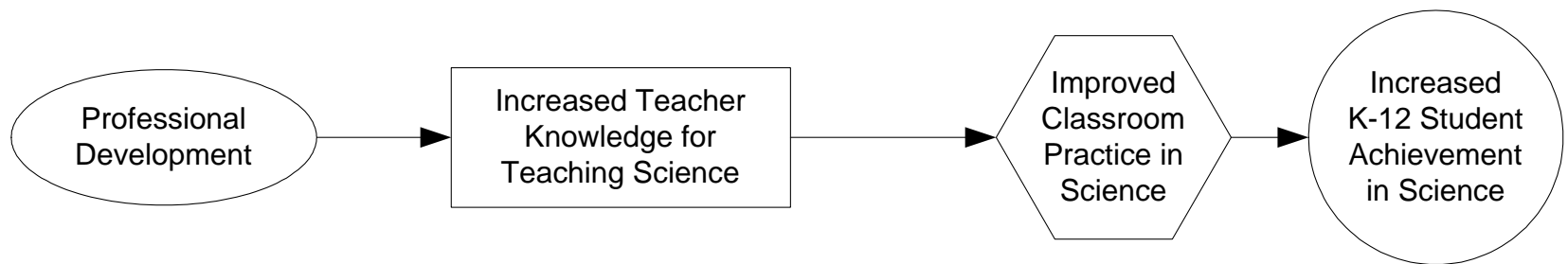
Comments? Questions?

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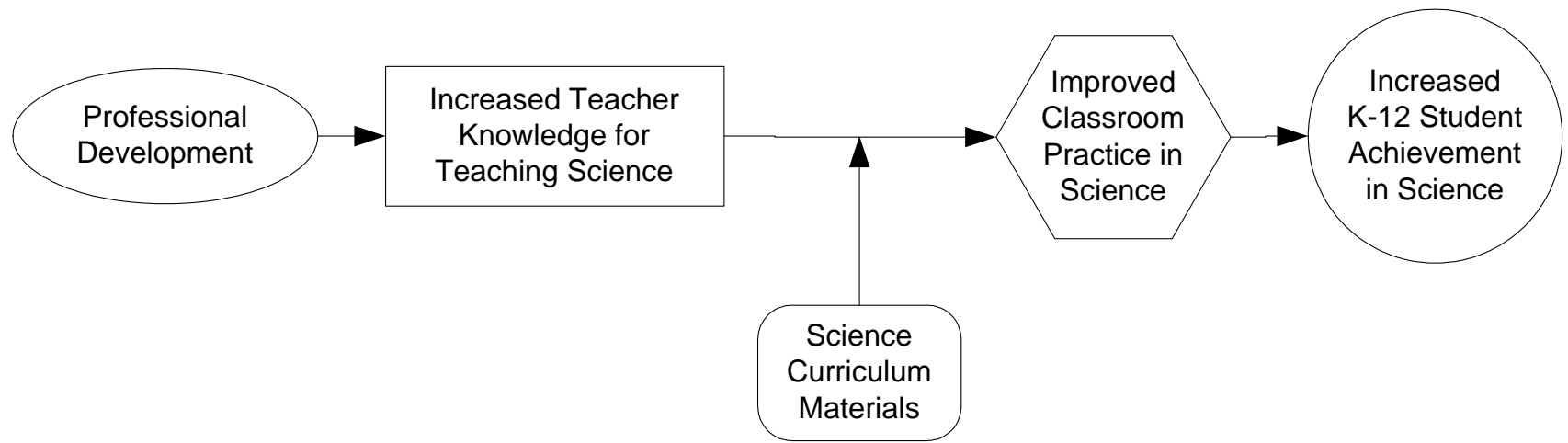
Part II

A Vision of Effective Professional Development

Implicit Model of Professional Development



Importance of Instructional Materials



Two key questions about Professional Development

- What knowledge and skills do teachers need for effective classroom practice?
- What types of professional development:
 - help teachers learn the necessary knowledge and skills
 - facilitate transfer of knowledge and skills to classroom instruction
 - result in improved student learning



What is effective professional development?

Professional Development: The Consensus View (Elmore, 2002)

- Focuses on a well-articulated mission or purpose anchored in student learning of core disciplines and skills
- Derives from analysis of student learning of specific content in a specific setting
- Focuses on specific issues of curriculum and pedagogy
 - Derived from research and exemplary practice
 - Connected with specific issues of instruction and student learning of academic disciplines and skills in the context of actual classrooms

- Embodies a clearly articulated theory or model of adult learning
- Develops, reinforces, and sustains group work
 - Collaborative practice within schools
 - Networks across schools
- Involves active participation of school leaders and staff
- Sustains focus over time

- Models effective practice
 - Delivered in schools and classrooms
 - Practice is consistent with message
- Uses assessment and evaluation
 - Active monitoring of student learning
 - Feedback on teacher learning and practice

Old View of PD

- Individual teachers attend summer workshops on college campuses
- Generic PD (e.g. “cooperative learning” or “inquiry”)
- Content taught separately from pedagogy
- Evaluation of how much teachers “like” the PD

New View of PD

- More emphasis on working with all or critical masses of teachers, at district sites, during academic year
- Content-based PD
- Integration of content and pedagogy in the context of practice-based materials
- Evaluation of impact on teachers and students

Coherence of PD doesn't happen by accident

- Need to look at articulation, K-8 (ideally K-12)
- Professional development is easier when all teachers at a grade level use the same instructional materials
- Need to provide incentives for teachers to engage in long-term professional development aligned with their needs
- Need to make sure principals share (and support) the same vision of effective science teaching

Importance of Involving Principals

"We realized that if principals are not behind you, if they're not supporting you, then you're not going to get a lot of the teachers out. If principals are not behind it, there's very little opportunity for change."

"What we found, it was really a function of the principals as to whether [the LSC] stayed as a priority for the five years."

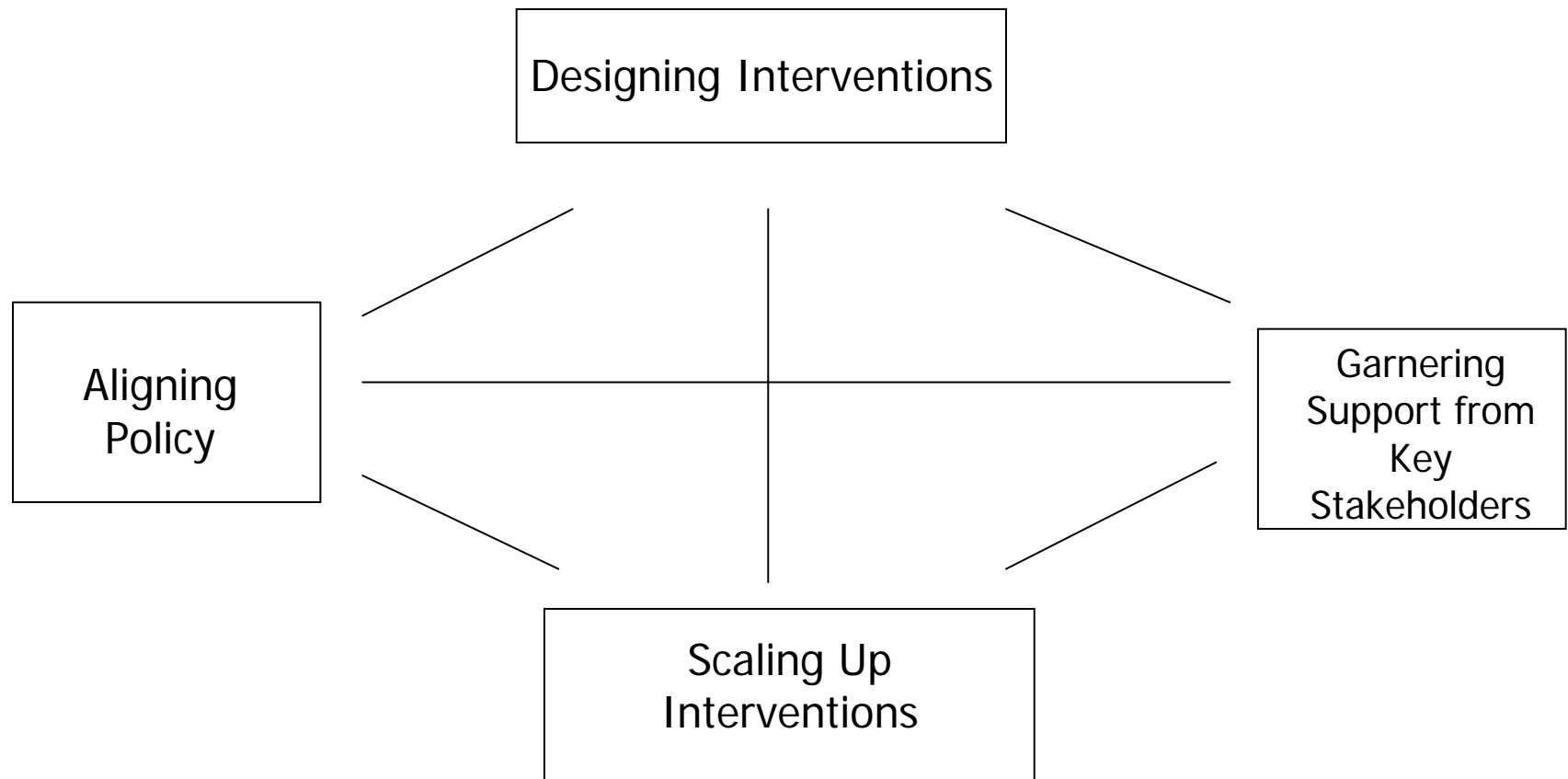
"The vision of the principal is a key determinant of how well standards-based science is implemented within a school."

"Never stop working with principals. You can never do enough to get them to understand what this kind of science is all about, what it looks like in the classroom, what it means in terms how it enhances their vision of literacy acquisition. The most important cog in the wheel is the building principal."

Tasks of Strategic Leadership: Developing a Shared Vision

- Of effective teaching and learning
- Of a reformed science education system
- Of the strategy for reform

Four Components of Reform Work



Designing “Interventions”

- Focus on priority needs in your context
- Select effective, promising interventions
- Pilot the interventions to get the “kinks” out and demonstrate their effectiveness

Garnering Support from Key Stakeholders

- Identify the key stakeholders
- Develop strategies to build support among key stakeholders
- Leverage the support of influential stakeholders

Aligning Policy

- Identify the most influential policies
- Leverage aligned policies to move forward
- Seek and create opportunities to align policies

Scaling Up Interventions

- Assess existing resources for scaling up
- Develop human resources for scaling up
- Develop infrastructure for scaling up
- Create a system for maintaining quality in scaling up



Handbook for Enhancing Strategic Leadership in the Math and Science Partnerships

http://www.horizon-research.com/reports/2004/mspta_handbook.php

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Closing Thoughts on Professional Development

- Professional development needs to be designed to achieve a particular purpose or set of purposes
- Think big, start small

Comments? Questions?

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