CHAPTER FOUR
Ratings of Lesson Quality

Introduction

The vision of effective mathematics and science education that guided this study considers the primary goals of mathematics and science education to be (1) helping students learn important mathematics and science concepts; and (2) deepening their abilities to successfully engage in the processes of mathematics and science. To achieve these goals, not only do lessons need to provide students opportunities to learn, but teachers also need to be very clear about the purposes of each lesson in relation to the specific concepts being addressed, in order to help guide students in their learning.

Note that while the goal of instruction in all cases needs to be understanding, in our view, understanding can be developed through well-designed lectures, well-designed hands-on activities, well-designed paper-and-pencil tasks, or any of a myriad of other strategies. The key is that the activities be designed to be purposeful, accessible, and engaging to students, with a clear and consistent focus on student learning of important mathematics and science concepts.

The Observation and Analytic Protocol developed for the *Inside the Classroom* study was designed to assess the quality of lessons in relation to this vision of effective mathematics and science instruction. In addition to rating specific components of the lessons, such as the accuracy of the mathematics/science content and the quality of the teachers' questioning, observers rated the likely impact of each lesson on students and provided an overall "capsule rating" of the lesson.

This chapter presents data based on the observed classrooms, weighted to represent all grade K–12 mathematics and science lessons in the United States. Data broken down by subject and grade range, again weighted to provide national estimates, are included in Appendices C–H.

Overall Ratings of Lesson Quality

As can be seen in Table 16, based on observers' judgments, only about a third of lessons nationally are likely to have a positive impact on student understanding of mathematics/science concepts, and 16 percent are likely to have a negative effect on their understanding; the remaining lessons would likely have no effect, or both positive and negative effects. Lessons are as likely to have a negative impact on students' interest in and/or appreciation for mathematics/science as they are a positive impact, with roughly a third of lessons in each category.

Table 16
Likely Impacts of Mathematics and Science Lessons[†]

	Percent of Lessons		
	Negative Effect	**Mixed or Neutral Effect**	**Positive Effect**
Students' understanding of important mathematics/science concepts	16	50	34
Students' interest in and/or appreciation for the discipline	27	41	32
Students' self-confidence in doing mathematics/science	20	50	30
Students' ability to apply or generalize skills and concepts to other areas of mathematics/science, other disciplines, and/or real-life situations	15	58	27
Students' understanding of mathematics/science as a dynamic body of knowledge generated and enriched by investigation	31	45	25
Students' capacity to carry out their own inquiries	21	55	24

[†] Data are reported by subject and grade range in Appendices C–H.

The scale observers used to provide an overall assessment of the quality and likely impact of the lesson is divided into the following categories:

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

Detailed descriptions of these levels can be found in the *Inside the Classroom* Observation and Analytic Protocol in Appendix A. Lessons are broadly categorized in this report as low in quality (1a, 1b, 2); medium in quality (low 3, solid 3), and high in quality (high 3, 4, 5).

Lessons judged to be low in quality are unlikely to enhance students' understanding of important mathematics/science content or provide them with abilities to engage successfully in the process of science or mathematics. While low quality lessons fall down in numerous areas, their overarching downfall tends to be the students' lack of engagement with important mathematics or science. Examples of low quality lessons include:

- A primary grade science lesson in which students drew their favorite animal, but never focused on science concepts;

- A mathematics class where students spent most of the time playing a mathematics-related game with no attention to the mathematics concepts implicit in the game;

- A science lesson that attempted to teach a 3rd grade class about buoyancy, clearly not developmentally appropriate for these students;

- A mathematics lesson in which the primary focus was on learning algorithms instead of on the meaning of concepts represented by the algorithms; and

- A science class where students followed the steps through laboratory procedures, but did not seem to understand why they were doing what they were doing.

At the other end of the scale, high quality lessons are structured and implemented in a manner which engages students with important mathematics or science concepts and are very likely to enhance their understanding of these concepts and to develop their capacity to do mathematics/science successfully. Regardless of the pedagogy (e.g., investigations, teacher presentations, discussions with each other or the teacher, reading), high quality lessons provide opportunities for students to interact purposefully with science/mathematics content and are focused on the overall learning goals of the concept. Examples of high quality lessons include:

- A lively discussion in a science class focused on interpreting and identifying trends in data collected in lab the previous day;

- A middle school mathematics lesson where small groups of students developed strategies to find the volume of irregularly shaped objects and shared them with the rest of the class; and

- A lecture where high school students were engaged in learning about how nerve receptors are differentiated to distinguish levels of pain.

In the middle, are lessons that are purposeful and include some elements of effective practice, but also include substantial weaknesses that limit the potential impact for students. The specific areas where "middle quality" lessons fall down varies widely and could be related to the content that is the focus of the lesson, how the lesson is designed and implemented, and/or the classroom culture. Examples include:

- A small group exploration that was short-circuited by the teacher, who told the students what they should find;

- A lesson in which the needs of a subgroup of students were not addressed;

- A lesson where students were ridiculed for asking questions, which interfered with the implementation of a well-designed learning activity; and

- A discussion that involved high-quality ideas, but was too fast-paced for many of the students.

As can be seen in Figure 2, based on observers' judgments, only 15 percent of K–12 mathematics and science lessons in the United States would be considered high in quality, 27 percent of medium quality, and 59 percent low in quality. Descriptions of lessons at each of these levels can be found in the subject-specific Appendices C–H.

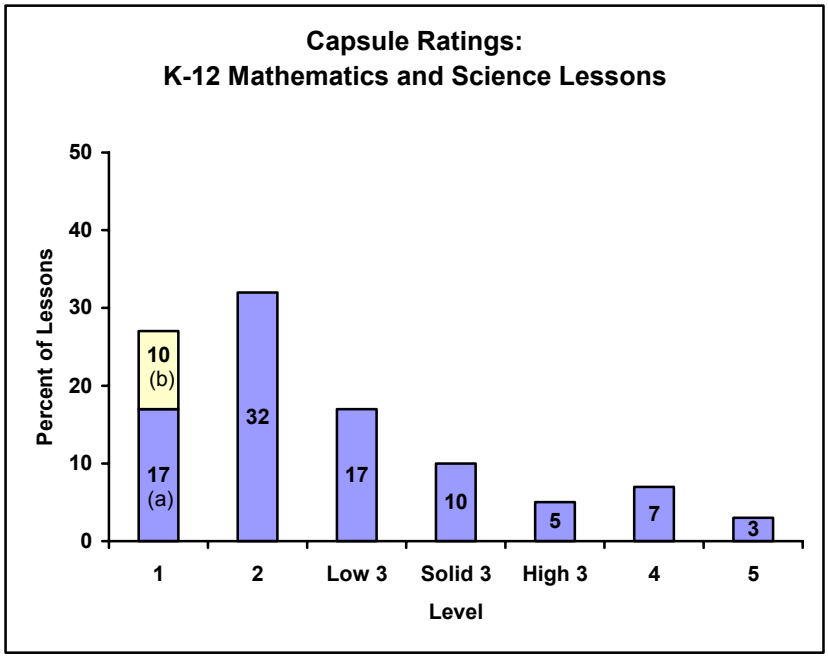


Figure 2

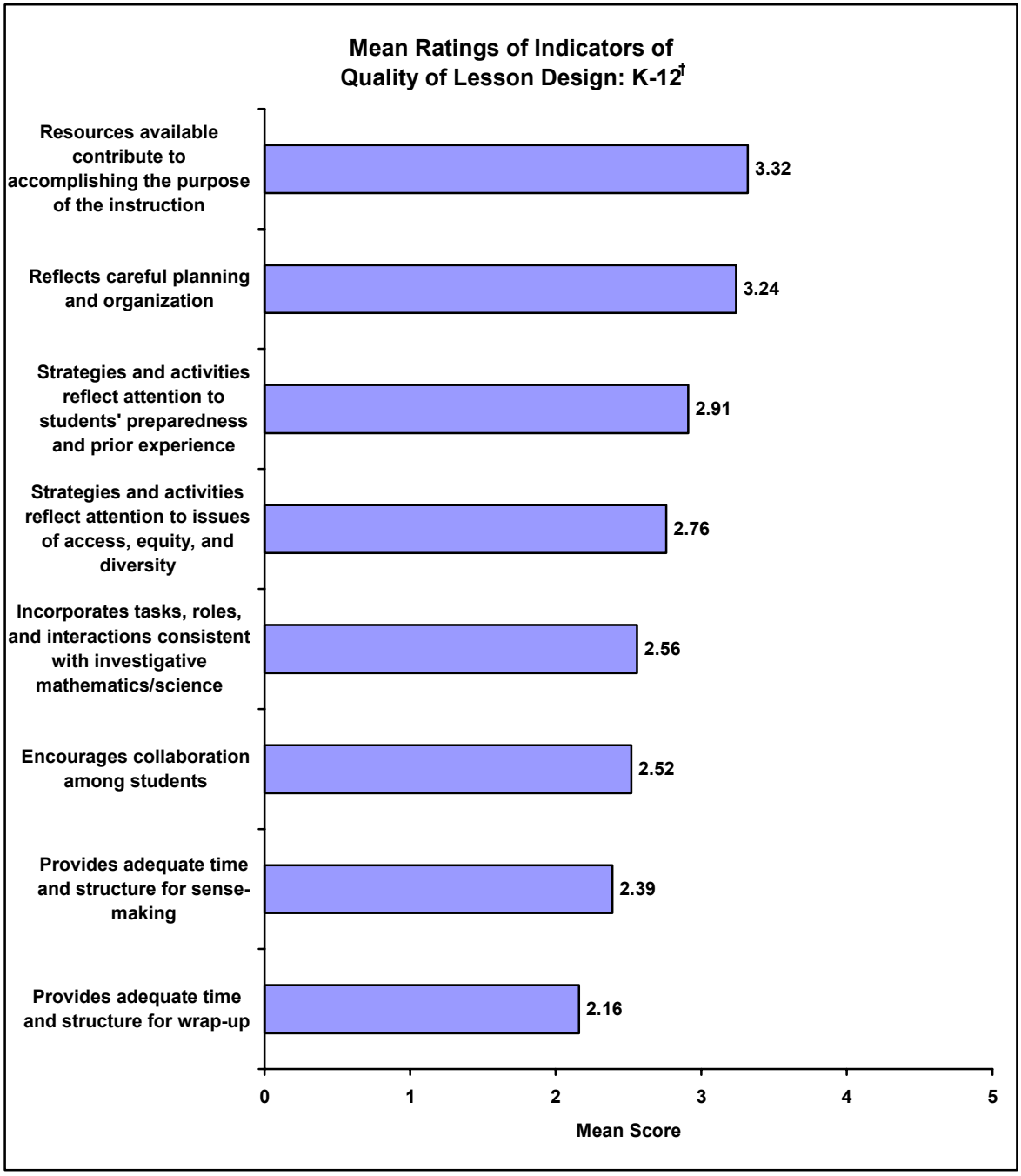
Ratings of Lesson Components

As noted earlier, *Inside the Classroom* observers assessed the quality of four components of each lesson: (1) the lesson design, (2) the lesson implementation, (3) the mathematics/science content addressed, and (4) the classroom culture. They rated specific indicators in each area, then assigned an overall rating to that component, providing a detailed rationale for their judgment.

Lesson Design

The lesson design (or structure of the observed lesson) generally encompasses the activities, the instructional strategies, the assigned roles, and the resources of the lesson. Indicators in the area of design include the extent to which the lesson reflected careful planning and organization, the extent to which the available resources contributed to accomplishing the purpose of the lesson, and the extent to which strategies and activities reflected attention to issues of access, equity, and diversity. Observers also rated the extent to which students were provided with time and structure for wrap-up and sense-making. "Sense-making" is broadly defined to include time for thought and processing and can occur in a variety of contexts (e.g., individually, small groups, and whole group) and either during an activity or as part of a wrap-up.

As can be seen in Figure 3, the strongest elements of lesson designs are the instructional resources used, and the planning that went into the lessons. Among the weakest elements are the lack of time and structure for sense-making and for wrap-up appropriate for the purposes of the lesson. Based on the *Inside the Classroom* observations, most mathematics and science lessons in the nation would be rated a 2 or 3 out of 5 for the overall quality of their designs. (See Figure 4.)



† Frequency distributions for these indicators are included in Appendix I.

Figure 3

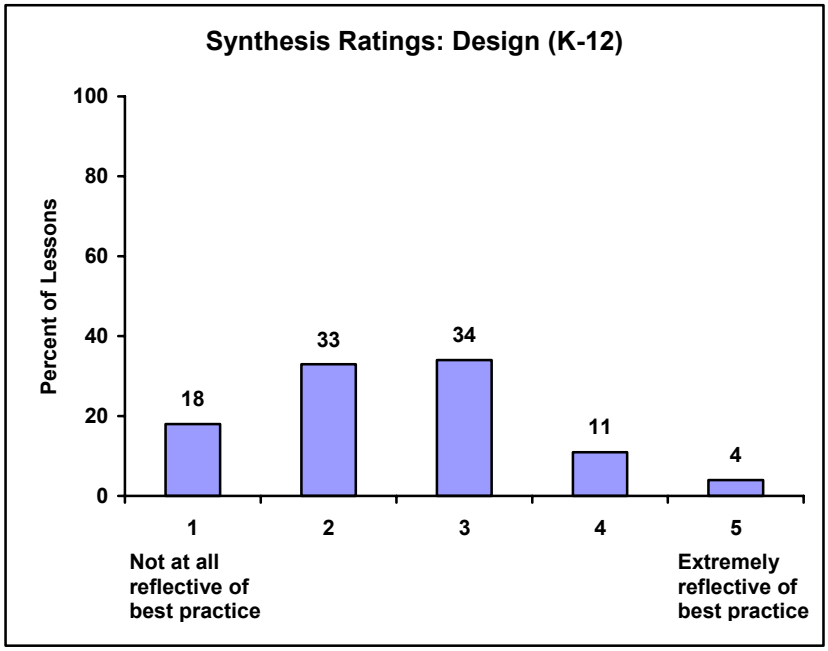
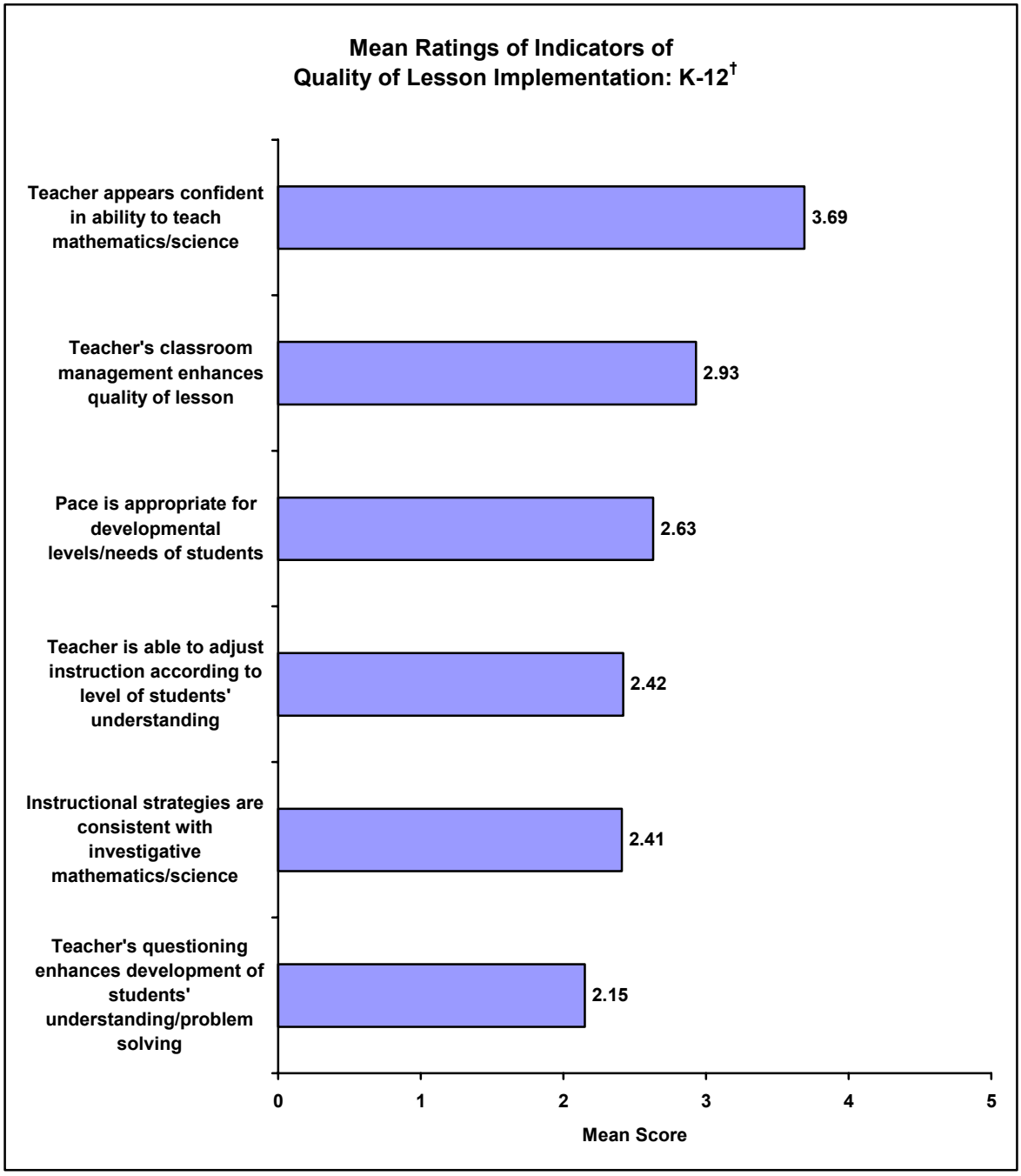


Figure 4

Lesson Implementation

Lesson implementation, the second lesson component assessed by observers, refers to how the teacher carried out the lesson. Indicators in implementation focus on the pace of the lesson, classroom management, teacher questioning, and the teacher's apparent confidence in teaching the subject. Observers also rated the extent to which the teacher's instructional strategies were consistent with investigative mathematics and science.

As can be seen in Figure 5, most teachers appear confident in their ability to teach mathematics and science. At the other end of the scale, teachers' questioning strategies receive generally low ratings overall. Based on *Inside the Classroom* observations, most mathematics and science lessons in the nation are clustered at the low end of the implementation scale, with a modal rating of 2 out of 5. (See Figure 6.)



† Frequency distributions for these indicators are included in Appendix I.

Figure 5

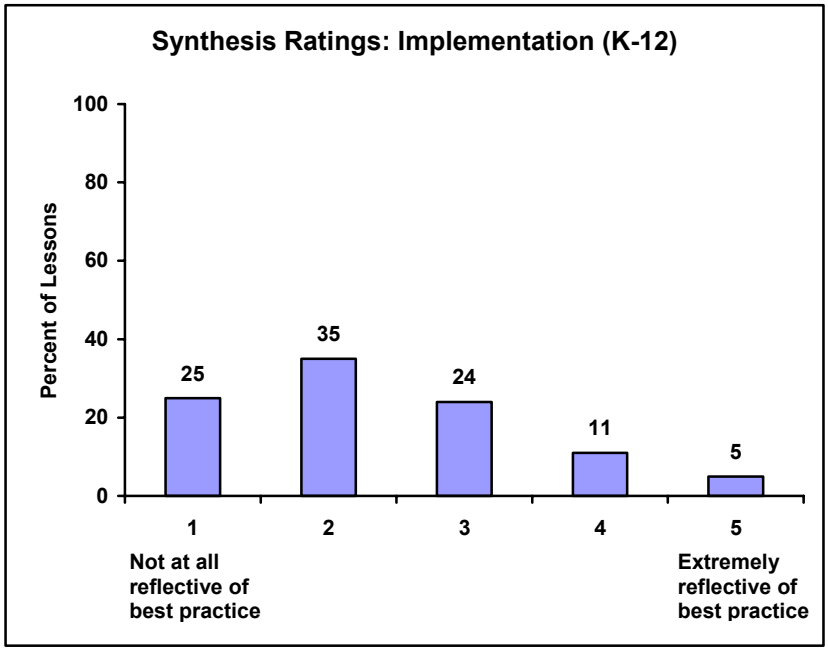
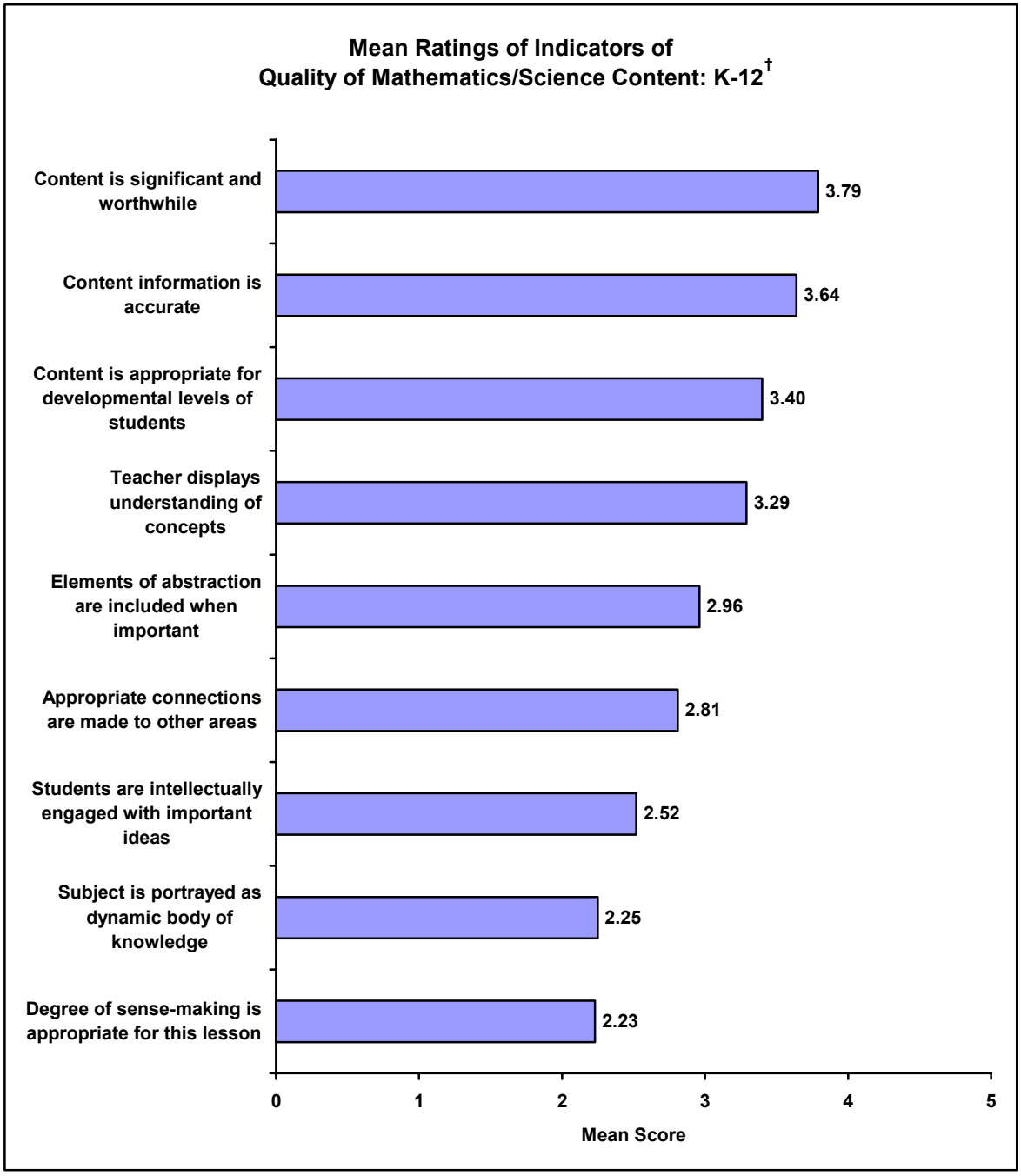


Figure 6

Lesson Mathematics/Science Content

Observers assessed the quality of the mathematics/science content of the lessons using a number of indicators. The quality of the content was rated based on its inherent importance in K–12 mathematics/science and its appropriateness for the particular students in the observed class. The extent to which students were engaged with the content and were able to make sense of the content were also assessed. Other indicators included: the extent to which the teacher displayed an understanding of concepts, the accuracy of the content, and the extent to which there were appropriate connections to other disciplines or to real-world contexts.

As can be seen in Figure 7, the mathematics/science content of lessons is typically accurate, significant, and worthwhile. Lessons are less likely to portray mathematics or science as a dynamic body of knowledge. Similarly, lessons tend to fall down in regard to the degree of sense-making of the mathematics/science content. As was the case with quality of implementation, the modal synthesis rating for mathematics/science content nationally is 2 out of 5. (See Figure 8.)



† Frequency distributions for these indicators are included in Appendix I.

Figure 7

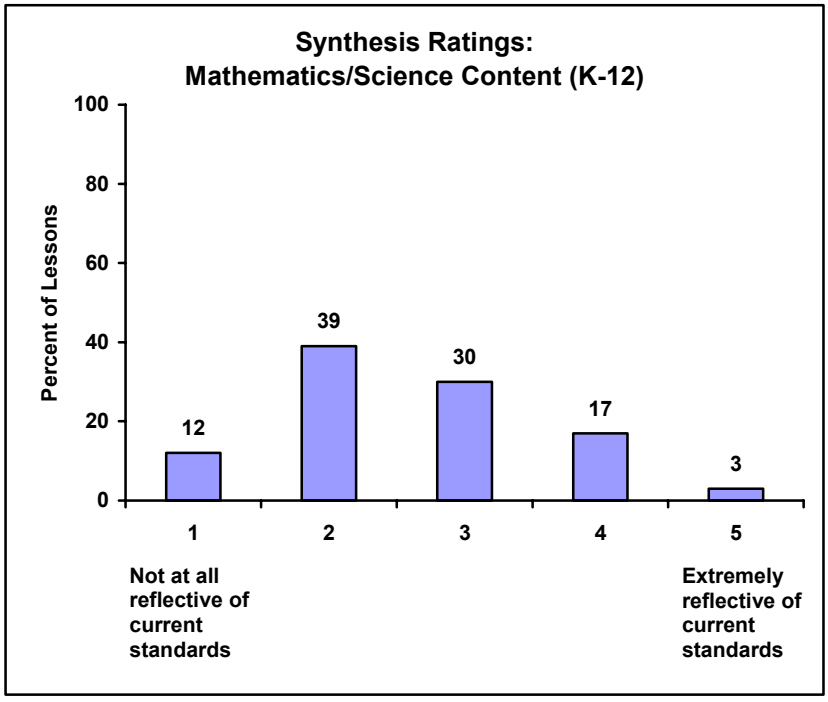
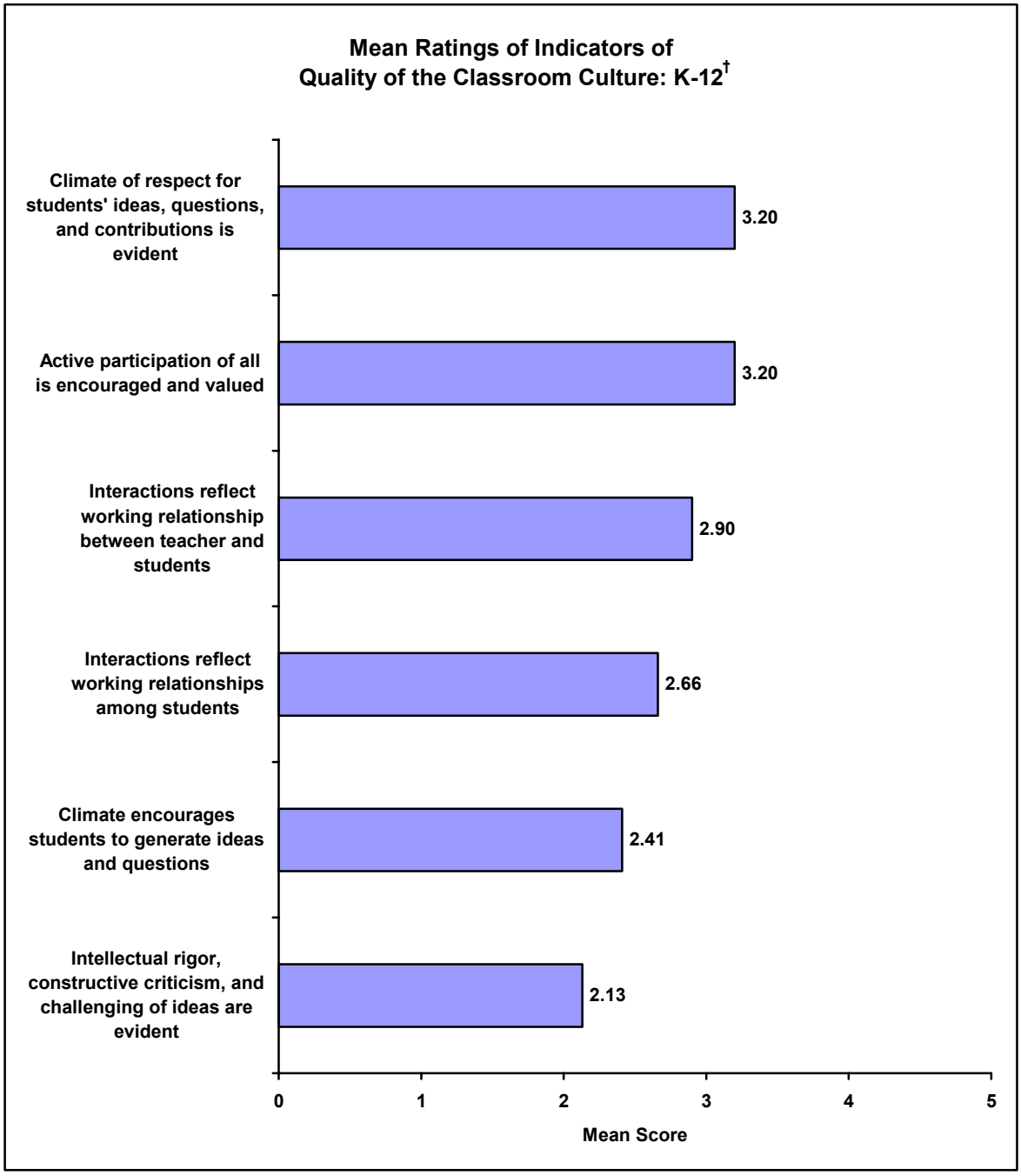


Figure 8

Classroom Culture

Classroom culture, the final component area assessed by observers, includes indicators of the extent and nature of the engagement of students in the class. It focuses not only on the quality of interactions among students and between the students and the teacher, but also on the rigor of the classroom climate. In addition, observers had the opportunity to comment on issues of equity and diversity that may have impacted the culture of the classroom. Sample indicators include the extent to which active participation was encouraged and valued; interactions reflected collaborative working relationships between teacher and students; and intellectual rigor, constructive criticism, and the challenging of ideas were evident.

Mathematics and science lessons are relatively strong in their climate of respect for students' ideas, questions, and contributions; and in the extent to which active participation of all students is encouraged. As a whole, lessons are weaker in the extent to which their climate encourages students to generate ideas and questions; and in the extent of intellectual rigor. (See Figure 9.)



† Frequency distributions for these indicators are included in Appendix I.

Figure 9

The overall rating for classroom culture differs from those for the previous component areas in that observers were asked to rate the extent to which the classroom culture interfered with or facilitated student learning. As can be seen in Figure 10, most lessons nationally would be rated a 2 or 3 out of 5.

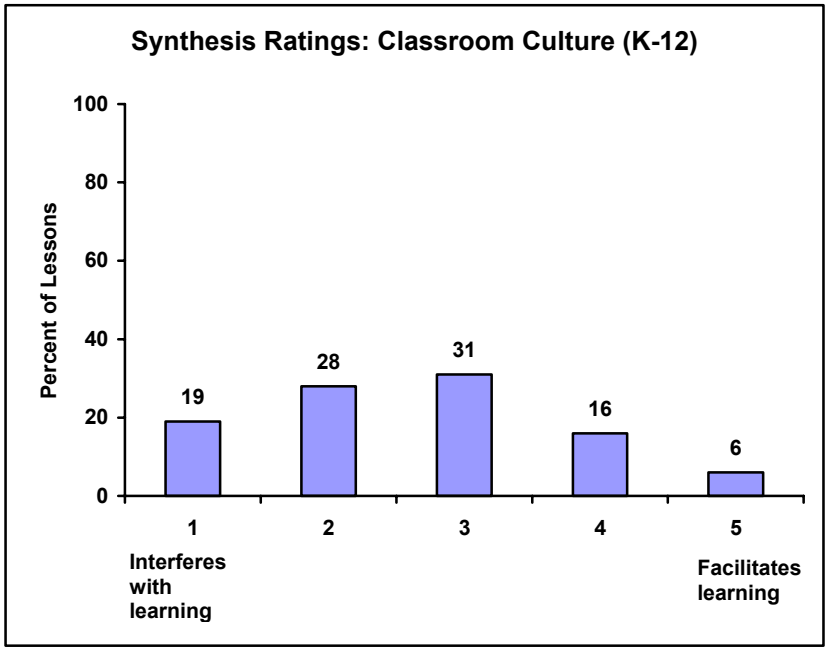


Figure 10

Indicators of High and Low Quality Lessons

As can be seen in Table 17, the vast majority of lessons judged to be effective, and roughly half of the lessons judged ineffective, in helping students learn important mathematics/science content have strengths in a number of areas, including content that is significant and worthwhile; teachers who are confident in their ability to teach mathematics/science; and teachers who provide accurate information. Where most high quality lessons are strong, but almost all low quality lessons fall down, is in such areas as engaging students intellectually with the mathematics/science content; portraying these disciplines as dynamic bodies of knowledge; having a climate that encourages students to generate ideas, questions, conjectures, and propositions; extent of intellectual rigor; teachers' questioning strategies; teachers' abilities to adjust instruction based on students' level of understanding; and the degree of "sense-making" within the lesson.

Table 17
Lessons Rated Strong on Each Indicator, by Lesson Quality

	Percent of Lessons		
	Overall Quality	High Quality	Low Quality
The mathematics/science content is significant and worthwhile	67	99	53
The teacher appears confident in his/her ability to teach mathematics/science	63	99	52
Teacher-provided content information that is accurate	56	91	47
The mathematics/science content is appropriate for the developmental needs of the students in this class	49	90	35
Active participation of all is encouraged and valued	47	85	28
The resources available in this lesson contribute to accomplishing the purposes of the instruction	47	84	30
The design of the lesson reflects careful planning and organization	45	89	23
There is a climate of respect for students' ideas, questions, and contributions	45	88	20
The teacher displays an understanding of mathematics/science concepts (e.g., in his/her dialogue with students)	43	97	23
Interactions reflect collaborative working relationships between teacher and students	37	91	15
Elements of mathematical/science abstraction (e.g., symbolic representations, theory building) are included when it is important to do so	36	85	19
The teacher's classroom management style/strategies enhance the quality of the lesson	34	84	11
The instructional strategies and activities used in this lesson reflect attention to students' experience, preparedness, prior knowledge, and/or learning styles.	32	85	11
Appropriate connections are made to other areas of mathematics/science, to other disciplines, and/or to real-world contexts	30	73	16
Interactions reflect collegial working relationships among students (e.g., students work together, talk with each other about the lesson)	29	71	10
The instructional strategies and activities reflect attention to issues of access, equity, and diversity for students (e.g., cooperative learning, language-appropriate strategies/materials)	28	80	5
The design of the lesson encourages a collaborative approach to learning among the students	27	82	6
The design of the lesson incorporates tasks, roles, and interactions consistent with investigative mathematics/science	26	82	6
The pace of the lesson is appropriate for the developmental levels/needs of the students and the purposes of the lesson	24	78	7
The climate of the lesson encourages students to generate ideas, questions, conjectures, and/or propositions	22	82	5
The instructional strategies are consistent with investigative mathematics/science	21	87	1
Students are intellectually engaged with important ideas relevant to the focus of the lesson	20	84	2
The teacher is able to "read" the students' level of understanding and adjust instruction accordingly	19	79	3
Adequate time and structure are provided for "sense-making"	18	81	1
Mathematics/science is portrayed as a dynamic body of knowledge continually enriched by conjecture, investigation analysis, and/or proof/justification	18	75	3
The teacher's questioning strategies are likely to enhance the development of student conceptual understanding/problem solving (e.g., emphasized higher order questions, appropriately used "wait time," identified prior conceptions and misconceptions)	16	73	1
The degree of "sense-making" of mathematics/science content within this lesson is appropriate for the developmental levels/needs of the students and the purposes of the lesson	15	79	2
Intellectual rigor, constructive criticism, and the challenging of ideas is evident	14	68	1
Adequate time and structure are provided for wrap-up	14	61	3