CHAPTER VII

Impact

The evaluation of the IMD materials addressed impact in three ways. First, we were interested in how those who were using the materials, either IMD-funded or non-IMD, assessed the impact. Second, to the extent possible, we sought information about how materials affected student learning. The study did not include testing of students; rather, we requested information during site visits about data collected at the classroom, school, or district level.

Finally, the study focused on how the use of materials affected classroom practice. Data related to classroom practice came from two sources: interviews or focus groups with users of the materials, both IMD and non-IMD; and observations conducted by WestEd and Abt Associates Inc. staff, using a structured instrument (see Appendix 3).

The interviews, focus groups, and observations that provided the information for this chapter were conducted in a variety of settings, including urban, rural, and suburban schools, and schools in which adoption was fairly new and those that had longer experience with the materials.

IMD Materials

Users of the IMD materials assessed their impact in multiple ways, including the extent to which:

- Teachers believed that the materials increased their own content knowledge;
- Teachers believed the products increased their use of reform-oriented pedagogy;
- Products increased student engagement; and
- Products increased student achievement.

Content Knowledge

Teachers of IMD-funded science products were more likely to report that using the materials increased their own knowledge of content than were those who used the mathematics materials, perhaps reflecting differences in how well they were originally prepared to teach the subject. Elementary school teachers appreciated the theoretical base that the NSF materials included, and high school teachers who used Project 5 believed their knowledge was extended through using the materials.

Teachers who used the science materials, particularly in elementary schools, reported that the IMD-funded materials increased their knowledge of science. Elementary school teachers often have little background in science, so schools often looked for strong teachers' manuals with clear concepts of what to cover. The teachers in the focus group for a comprehensive elementary school science project highlighted their appreciation for the clearly presented new content:

> For teachers who do not have a background in science, the materials give them a structure and a story line, since each concept and each grade builds upon the next. It provides a good introduction to certain meaningful science concepts for teachers. It becomes a base for teachers to use to teach science. The first-grade teacher in the group said that the curriculum gave her greater comfort with science: "It made me not dread science." *(Summarized from Focus Group, Project 21)*.

Similarly, teachers reported that the manual that accompanied Project 27 was clear and easy to follow, with a thorough overview and presentation of kits. Even supplemental materials, such as Project 20, were cited as improving understanding of science concepts and making it easier to teach science.

In contrast, teachers also reported that some IMD science materials required prior content knowledge. One teacher using a high school course commented:

> "I think the materials would scare the crap out of any teacher who is weak in science. You can't go to the text to educate yourself. You have to go to the research, which can be intimidating." *(Teacher Interview, Project 16).*

Reform-oriented Pedagogy: Teachers' Views

An explicit purpose of the IMD program is to encourage reform-oriented pedagogy by the nature of the products it supports. Teachers of the comprehensive IMD materials often remarked that the products stimulated them to use more student-led investigations and discovery activities for students, hands-on exercises, and exploration of mathematics and science concepts. When teachers of IMD materials remarked that their teaching had not changed, it was typically because they reported that they were already using an investigative, hands-on approach.

With the mathematics curricula, most teachers at each level believed they had changed the ways they taught, especially in moving away from teaching by rote.

> "The classroom is more active and student driven. The teacher's role is different. You are a member of the community and not just into exposition. You can't predict what's going to happen in the lesson because students often have questions that the teacher can't anticipate. It creates a learning community in the classroom. he content is so different that it drives changes in practice." *(Focus Group, Project 19).*

> "We're not teaching by rote but by solving problems, transmitting data, and working in teams." *(Focus Group, Project 8).*

> "It has changed the way I teach dramatically. It has changed how I teach, how I deliver information, how I engage students to be active participants in their education. It has also changed the physical appearance of the classroom (it's messier now), and how I assess student learning. It is exciting to watch kids share knowledge, and to share their excitement in the learning process." *(Focus Group, Project 5).*

With the comprehensive IMD science curricula, elementary teachers often remarked that although how they taught science had not changed, their attitudes about science were more positive and their enjoyment and excitement in teaching the subject had increased, reflecting a common research finding that teachers believe that they have "always done" what is required (Spillane & Zeuli, 1999). Middle and high school science teachers, on the other hand, saw changes in their pedagogy. As several teachers reported in focus groups:

> Prior to implementing [the product], his classes were two-thirds lecture and one-third activity based. During the activity-based portion, he might have an entire

class devoted to computers or wet lab or a hands-on activity. Now his classes are more fluid, and a single class will incorporate two or more of these aspects at a time. *(Summarized from Teacher Interview, Project 16).*

The materials forced a less passive approach to teaching (that is, less of the "lecture, read, answer lab questions" format). Teachers could not use "cruise control" to teach. The exploratory labs and student questions dramatically changed the teaching of one teacher because the program requires her to answer student questions when sometimes she doesn't know the answer. *(Summarized from Focus Group, Project 12).*

The high school course is very student oriented rather than being teacher oriented. There is far more emphasis on students' sharing ideas in small groups and not on teacher lecture. The materials give guidelines for running the classes in this way. Changing the way of teaching was hard. As one teacher reported: "I had a rough time turning the room over to the kids. I have 23 years of being in total control with a lot of straight lecture. When I started [the course] that first year, turning the classroom over to the kids as a town meeting and saying, 'Ok you have two days to plot out your diet and figure out food values' — that was tough to do and maintain control." *(Summarized from Focus Group, Project 2).*

Some science teachers who did not change their pedagogy experienced changes in their attitudes toward science based on their students' and their own enjoyment of the materials:

One teacher commented that [the product] has had an impact on her teaching in the sense that she had always found plant biology to be boring and really didn't like teaching it, but now she looks forward to teaching the unit because her students like it so much and because they get so much out of it. *(Summarized from Focus Group, Project 20).*

Comprehensive materials seem to be more likely than supplemental materials to have an impact on pedagogy, at least as the teachers reported it. The most common pedagogical changes noticed by teachers interviewed about IMD supplemental materials, was incorporating media, such as the Internet, videos, and special tools, into teaching. However, the teachers who used supplemental materials identified and selected them and were likely to characterize themselves as using reform-oriented pedagogy prior to implementing the IMD materials.

The new strategies make teaching more challenging for the teachers. The curriculum is no longer something they can simply pick up and implement, almost by rote. Instead, they need to study the materials in order to understand the concepts and strategies. Many teachers reported that far more preparation time was needed than was indicated by the publisher, including time to incorporate more group work into the day.

Reform-oriented Pedagogy: Classroom Observations

In addition to using focus group and interview data to collect teachers' views on the impact IMD materials made on their pedagogical practice, WestEd and Abt Associates Inc. staff observed in classrooms in which IMD-funded comprehensive materials were used, guided by a structured observation instrument. The instrument addressed the overall quality of instruction, mathematics or science content, classroom culture, and teacher behaviors. We found that both mathematics and science classes were interactive environments in which hands-on activities were notable, although there was more variety in the science classes.

Students in most mathematics classes we observed were engaged in problem solving and hands-on research. In elementary classrooms, we saw many student oral presentations. In contrast, there were few formal presentations by teachers. In fact, only at the middle school level did a majority of classes observed (70 percent) rely on formal teacher presentations.

Across all criteria included in the instrument, the overall quality of the mathematics lessons observed was high, especially in elementary school. The instrument rates scores of 4 as "accomplished, effective instruction" and 5 as "exemplary instruction," and the average ratings were 4.5 (elementary), 3.7 (middle school), and 2.7 (high school). The low high school rating is due to one class that was rated as exemplifying "ineffective" teaching.

Observers also rated the content of the mathematics lessons highly, with average ratings of 3.8 (elementary), 4.1 (middle school), and 4.2 (high school) on a five-point scale. The instrument addressed issues such as whether the content was appropriate, significant and worthwhile; accurate and relevant to the needs/interests of most students; and portrayed as a dynamic body of knowledge.

The observers gave high ratings to items related to the culture of the classroom, especially the extent to which teachers encouraged active participation and collaboration among students and showed respect for and collaborated with students. Average ratings ranged from 3.7 to 3.9 across the three school levels.

Teacher behaviors, such as the teacher's management style, pacing of the lesson, confidence in using the materials, and questioning strategies, were less highly rated. Averages ranged from 3.2 (high school) to 3.4 (elementary school) to 3.8 (middle school).

One observer described an exemplary lesson in numeration and place values among first graders:

> Students are organized in stations, with the teacher leading one station. Students work on a problem and share solutions with the group. The problems cover the different skills of the unit and allow the teacher to assess if there are students who are having difficulty with the material. Students are engaged in a variety of tasks that make them responsible for their own learning and the learning of their peers. Most students are eagerly participating in the activities and in sharing their ideas with each other. There are enough manipulatives so that all students have the opportunity to work with them. When students arrive at different answers, they discuss their work and come to an agreement. The activities are well structured to provide students with the opportunity to practice what they have been learning in the unit. It also allows students to teach each other if there are concepts that are still unclear to some.

Among the science classes observed, the major activities were hands-on science with some problem solving by students. Teachers made formal presentations in half or fewer of the classes. The elementary grade science classrooms received consistently high marks — 4.0 in overall quality, 3.8 each in content and in classroom culture, and 3.7 in teacher behaviors. Ratings for the middle and high school science classes were lower, with most average ratings at or near 3, the mid-point of the five-point scale. There was far more variability in ratings in science than in mathematics, with scores ranging from 1 ("activity for activity's sake") to 4 ("accomplished, effective instruction”).

In a highly rated elementary science class, where first graders were focusing on the properties of balls of clay, one observer wrote:

> The teacher was completely confident with the subject lesson. She kept the students engaged, asked them questions and really tried to have them come up with answers, encouraged them to think, and to try out other questions. The teacher continually came around as kids were working in groups to ask them questions and listen to what they were finding. Kids were asked to draw and write about what they found (both individually and in groups). The teacher then asked what was found, wrote findings on the board and led a discussion comparing the properties of balls....It was an example of what can happen with a great curriculum and a wonderful teacher.

Among the lower scoring high school science classes, observers found that one teacher who had reportedly not bought into the IMD curriculum taught very traditionally, with emphasis on drill and practice. In another class, the observers wrote that the teaching was very “book-bound,” with the teacher neither giving students sufficient time to develop their own ideas nor pushing them academically.

Student Engagement

Although we have no independent measures of student engagement, teachers interviewed consistently spoke of increases in student engagement using the IMD materials, across comprehensive and supplemental materials, grade levels, mathematics and science.

Teachers of comprehensive mathematics materials said:

> Students are no longer afraid of math. “Students actually look forward to doing math” one teacher remarked. Another teacher remarked that she had a student who would cry whenever they did math, yet since using [an elementary school math program], the student is very happy. *(Focus Group, Project 10).*

> There is a better level of student engagement. Students have much more conversation with peers about math. As the year goes on, students tackle more complicated problems with less teacher help. The questions students ask are thoughtful rather than procedural. There is greater diversity in responses to questions. Students are more willing to take risks. *(Focus Group, Project 19).*

> “I like the way it engages students in mathematics. Students learn to be in control of their own learning. It’s not clear whether students are developing better math skills. What is clear is that students’ belief in their ability to do math is increasing dramatically. In their writing, they seem to think they understand math. For the first time, all students are moving on in math and enrolling in courses beyond what is required. This is remarkable, particularly for those students who have always struggled with and disliked math.” *(Focus Group, Project 5).*

Teachers reported increased student engagement with supplemental materials for mathematics as well. Videos provide a different angle for students that they can grasp right away and they were reported to be fun to watch. One tool was highly praised because it allowed students to explore spatial relations and geometric properties that would have been very tedious by hand. Teachers reported that students see the results immediately, which helps attract and hold their attention.

Science teachers also reported increases in student engagement:

> "The students do like using the materials....The subject holds their attention. They are solving problems and coming up with solutions, and they are having real discussions. The students come up with more questions, and even if they do not fully grasp the concept right away, the concept is on the way to being realized." *(Focus Group, Project 21).*

> "Learning is coming from within, not from without. The lessons make science real for kids. It builds a strong conceptual understanding of basic science principles. The lessons are fun and really hold kids' attention." *(Focus Group, Project 22).*

> "Subjectively, I think we're doing a better job getting students more interested in coming to school on a daily basis. I get testimonials from parents to this effect." *(Focus Group, Project 4).*

> "The students' reactions are very positive. They do not want to be absent when the program is in use and they appear to be eager to learn as much as they can about how the cars are working. The students apparently go home and talk endlessly with their families about what they are learning." *(Teacher Interview, Project 20).*

> Students become very attached to their [materials] and are extremely engaged in following the developmental process.... Two students with whom I was sitting had both named their materials, and according to them, almost all of their classmates had also done so. Both were very positive about the unit. One commented: "This is the best part of science, you know, where you get to do stuff in the labs." The other student agreed, saying: "It's better than if you watch a time lapse video because you're doing it yourself and it's yours and you can see everything happening." *(Summarized from Classroom Observation and Focus Group, Project 21).*

Across both mathematics and science materials, teachers often reported that IMD materials were suitable for a broad range of students. Several special education teachers spoke of the usefulness of hands-on materials for their students. In addition, two middle school programs that integrated technology were given high marks for increasing the representation of girls in technology. In one site, two years ago, the seventh grade technology education class had only two girls, but with the IMD-funded materials, girls are half the students and are full participants. One anecdote illustrates a girl's involvement in technology both within and outside the classroom:

> A student asked her father if she could have new bedroom furniture and her father replied that he didn't think that she was mature enough. [We're not sure why he thought that, but that's the way the story is told.] While he was away on a business trip, she took the dimensions of her room and designed and developed a scale

> model of the room, complete with what she had in mind — bed, dressers, study/computer area, etc.— and presented it to her father when he returned home. Her father, impressed with her initiative and the detailed manner in which she had thought through and presented the design, agreed to buy her new furniture. The furniture arrived while her father was away on another business trip and her mother told her: "Well, I guess we'll have to wait until your father gets back from his business trip to set up your new room." The daughter was not so easily daunted as the mother and headed down to the basement to get all the tools she needed and started assembling the room on her own and had everything in place before her father returned home. Her teacher believes that this anecdote demonstrates some of the types of problem-solving skills that students use in the… classrooms. Furthermore, she described the student as a "princess" who, prior to taking the technology portion of the course, would never have dreamed of picking up hammers, wrenches, and screwdrivers to assemble her new room. *(Summarized from Focus Group, Project 17).*

Student Academic Performance.

Most of our information about student achievement comes from teachers' assessment of student progress, although some teachers reported results from norm- or criterion-referenced tests in mathematics, with some limited information about possible impact coming from the classroom observations. Formal achievement data comes primarily from sites in which the materials were adopted at the district or school levels.

Perhaps most strikingly, teachers said they assessed students differently from their previous practice. For example, teachers of an elementary-level mathematics curriculum noted:

> "[Before implementing this program] we probably assumed that students knew more than what they really did about certain concepts. Even though students (especially the high level students) were doing the problems and performing well, they often did not have a real understanding of what it was we were teaching. The explanation part of the materials made us take a closer look at the strengths and weaknesses of students." *(Focus Group, Project 10).*

Teachers gave multiple examples of their assessments of student learning, often focused on students explaining the strategies they have employed in solving problems. Several teachers also observed that students were applying strategies they learned to situations outside class (Project 15).

Teachers using the IMD science materials also reported that students were more confident in themselves as learners, were now more independent and self-starting, and had built their social skills because of the need to gather information and make presentations as part of small groups. A middle school teacher echoed comments from other middle and high school teachers about what students learn from IMD science materials:

> These materials encourage students to develop and test their own hypotheses.....He finds that his students are now more willing to take these kinds of risks. He finds that girls, in particular, seem to talk more in class. He used the example of a girl in his class who collected data and believed that she had refuted a widely accepted scientific theory. She was confused and thought she had made

> a mistake, but wasn't sure where or how. She came to the teacher to talk through what she had done. As she explained what she had done, she figured out what she had done wrong. According to the teacher: "She thanked me for listening, but she solved the problem herself. Students get into the process enough to develop a gut instinct and say to themselves 'Okay, I need to redo this and this and this.' Stuff like that is good for kids. They're not so dependent on us for what they understand." *(Summarized from Focus Group, Project 16).*

Although teachers of the IMD-funded mathematics materials reported higher levels of sophistication in thinking mathematically, some worried that students' computational skills were inadequately addressed at several grade levels.

Several implementing sites assessed student achievement on the comprehensive IMD-funded mathematics products through state or district norm-referenced tests. These are cross-sectional designs (e.g., 8th grade students in one year compared with 8th grade students in the next) with no comparison group. Hence, attributing changes in achievement to the products and not to other factors is problematic.

For the two comprehensive elementary school mathematics programs for which users reported data (Projects 10 and 15), test scores have improved. One experienced an initial drop in standardized test scores and then gains. Teachers reported being a little surprised by the gains because they were on norm-referenced tests, and they decided to readopt the materials on the basis of the gains.

At the middle school level, all three comprehensive math programs had achievement data. The district adopting Project 19 looked at cross-sectional gains in sixth graders and eighth graders over several time points, and this year the district is beginning a longitudinal study to track the same students for five years. Increases in problem-solving skills among upper middle school students was attributed to Project 11, although some in the district think that increased mathematics scores could be related to the district's paying more attention to mathematics in general. In another district, advocates attributed increases in student achievement on the state assessment to the middle school math program (Project 1), although other teachers claimed that differences in the cohorts of middle school students could have been responsible. At the high school level, Project 5 showed improvements in test scores but as with other levels, attribution is difficult.

Once products were adopted by a district or school, cross-product comparisons of a product's relative impact on student learning were rarely made. Four of the seven comprehensive IMD math products were adopted either district- or school-wide, so no other products were available as comparisons. A fifth product was adopted as an alternative to the standard curriculum, but no achievement comparisons have been made. Another comprehensive high school math curriculum was also adopted as an alternative to the standard curriculum, with about 20 percent of students enrolled. The district visited is just beginning to assess the relative effectiveness of the two curricula through student grades, persistence in taking math courses, SAT/ACT results, and state test results. The final district in this group was cited in the case study of adoption, above.

Among the nine comprehensive IMD science products, none conducted formal student achievement assessments, nor was student achievement compared with other products. No student performance data were available about supplemental materials, either in math or science. This is not surprising because such assessments would have required considerable methodological sophistication.

Classroom observers were asked to rate the "likely effect" of the lesson observed on students' understanding and self-confidence. We found that observations supported the finding that better implemented materials were deemed to be likely to affect student outcomes more than poorly implemented materials.

Elementary mathematics classes received high ratings in such areas as student understanding of: mathematics using multiple approaches (4.3 on a five-point scale); science as a dynamic body enriched by investigation (4.0); and the importance of mathematics and science concepts (3.5). Observers also gave high marks to the likely effects of the lesson on student self-confidence in doing mathematics (4.2). At the elementary school level, the IMD products received higher ratings than did the non-IMD products.

The ratings of middle school mathematics classes were also very high (3.9 to 4.4) except in mathematics as a dynamic body of knowledge (3.2), but high school mathematics ratings were generally around 3, the mid-point on the five-point scale, and lower than elementary or middle school. However, the high school IMD mathematics ratings were higher than those given in classrooms using non-IMD materials, particularly with regard to likely effects on student understanding of important mathematics concepts (3.7 vs. 2.9); of mathematics as a dynamic body of knowledge enriched through investigation (3.0 vs. 1.5); and on students' self-confidence in doing mathematics (3 vs. 2.5).

The likely effects of the IMD science lessons were all above 3.5 at the elementary school level, around 3 at the middle school level, and between 2.5 and 3.2 at the high school level. These lower scores parallel the generally lower implementation ratings that science curricula received from the classroom observations.

Non-IMD Products

The information presented in this section must be interpreted with care. Few teachers of the non-IMD materials were as conscious of their own pedagogy as were many of the IMD teachers, and fewer of them reported changes in practice. We were intrigued by the difference in self-reflection between teachers of IMD products and those using non-IMD products, but the finding must be placed in the context of the fact that the teachers we observed and interviewed were "nominated" by developers or publishers. They may have been selected because of their reflective natures, reflective teachers may gravitate to reform, or the materials may stimulate reflection. Additional research is necessary to resolve the matter.

Further, although the observations illustrate that teachers of non-IMD materials tended to use more traditional instructional techniques, the difference may not be attributable to the products in use. Indeed, at least one teacher was observed using an IMD-funded and a non-IMD product, and her practice was the same with both. In short, far fewer teachers using non-IMD-funded curricula than IMD-funded curricula reported impacts on:

- Content knowledge
- Reform-oriented pedagogy
- Student engagement
- Student outcomes

Each of these issues will be discussed in the following section.

Content Knowledge

Only one teacher of non-IMD-funded materials reported any impact of the materials on content knowledge:

> The curriculum has made it much easier to teach science. Science is not my strength, so it was more difficult for me to get children excited about learning science. [The curriculum] has become the basis of how I teach.

This teacher's experience echoes that of elementary science teachers using several of the IMD-funded elementary science curricula, described above.

Reform-oriented Pedagogy

Far fewer teachers using non-IMD-funded curricula reported that the materials had an impact on their instructional approaches, which is not surprising because the materials are quite traditional, or only moderately reform-oriented. One teacher using one of the more reform-oriented curricula noted the following change in her instructional approach:

> The roles reversed. Before we would stand up in front and say "Okay, this is the program. This is the answer. This is how I got it—now you do the same thing." Now it's the reverse. "You have to come up with the answer and you have to explain it to me." *(Teacher Interview, elementary school non-IMD mathematics curriculum.)*

Another teacher using an integrated mathematics curriculum reported incorporating more activities and making better connections between mathematics and science than in her previous practice.

Other teachers believed the materials they were using supported appropriate classroom practice, but the real motivation for their pedagogy came from other factors. One chemistry teacher noted, for instance, that most of his students are not there for the fun of chemistry, so he has had to do everything that he can to draw them in and engage their interest. Although the variety of approaches in the curriculum helps, he believes it is really up to him to engage their interest. Teachers in another district saw new trends in education and the influence of a "change agent" teacher in their school as the forces behind their move to more concept-driven and hands-on approaches to learning rather than the materials they are using.

Classroom observations revealed two differences in the use of IMD and non-IMD materials. First, the classrooms using non-IMD materials were more likely to have formal teacher presentations than were those using IMD-funded materials. Observers indicated that 75 percent of all non-IMD classes included formal presentations as a major activity, although about half also had students engaged in hands-on research and problem-solving work. Second, non-IMD classes were less likely to use technology. Although few observers in either IMD or non-IMD classes rated technology use as a "major" activity, the non-IMD classes had less use than did the IMD classes.

Student Engagement

Teachers using non-IMD materials provided us with fairly few examples of impacts on student engagement, in contrast to the many testimonials offered by teachers using IMD-funded materials. The examples all come from teachers in schools implementing more reform-oriented curricula.

> They enjoy the math class more when we do it, and I will forever use it. *(Teacher Interview, reform-oriented non-IMD mathematics curriculum).*

> [The curriculum] does an excellent job in making students feel good about themselves and their ability to do math. *(Teacher Interview, reform-oriented non-IMD mathematics curriculum).*

One teacher, however, questioned whether increasing student enjoyment was an appropriate goal:

> With integrated mathematics, it's a way of making the kids enjoy it more, but I am not convinced that it helps them any more. I would like to see evidence that integrated works better than the traditional methods. Publishers need site studies showing their curriculum's effectiveness. *(Teacher Interview, non-IMD high school mathematics curriculum).*

Except in one school, where teachers reported students as "hating" their middle school science text, teachers using more traditional curricula gave fairly curt responses, indicated the curricula meet their students' needs, and students either liked the materials or at least thought that they were "okay."

Academic Performance

None of the districts we visited shared information about student achievement on either norm- or criterion-referenced tests. Two districts using integrated mathematics curricula reported that more students in their districts are taking mathematics. One district, in fact, had adopted the integrated mathematics because they wanted to increase the numbers of students taking advanced mathematics. Although pleased with increased enrollment, they will not consider the adoption a success until they have some evidence that test scores are also improving.

Conclusion

IMD-funded products are designed to change how teachers think about science and mathematics, as well as how the content and pedagogy they employ when working with students. Comprehensive materials are more likely to have an impact on teacher conceptions and practice than are supplementary materials.

When teachers do not implement the materials as designed, the impact on classroom practice and student engagement is decreased. In contrast, however, when the IMD materials surmount the many barriers to appropriate implementation, classrooms are places in which students are highly engaged in important learning activities. We saw a number of such examples in the study. Consequently, we believe that the gap between project intention and actual use and impact comes less from the materials themselves than from the contexts in which they are used.

The strength of the products is shown by the fact that almost all the IMD materials were well implemented in a few places, and all had positive results when they were.