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Differentiation in Action: Developing a Logic Model for Responsive Teaching in an Urban Middle School

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Abstract

Research has suggested that differentiation is a responsive approach to teaching rather than a set of strategies. In this study, researchers generated a logic model to describe how members of a two-teacher team collaborated to differentiate instruction and to examine the learning connections that five seventh graders made in an integrated unit. Data from interviews, observations, and work samples showed how teachers encouraged engagement by identifying students' strengths, tapping interests, and extending their thoughts. Students' engagement with the unit varied according to connections they made with teachers and information. The revised logic model more specifically described how teachers attempted to create connections and how students responded. Results illuminate some of the dynamics of differentiation and might provide a foundation for hypothesis testing in other settings.

Introduction

Calls for school reform have often emphasized the need for teachers to encourage student engagement with ideas. Jackson and Davis (2000) advocated a sharper emphasis on academic development in the middle grades to foster such engagement. To encourage higher levels of reasoning, many school districts have stressed "differentiated instruction." As these efforts have grown stronger, studies have demonstrated that notions of differentiation vary considerably, and implementation is often complex (Carolan & Guinn, 2007; VanTassel-Baska, et al., 2008).

In this investigation, researchers designed a study that would enrich and extend a previous case report to analyze these dynamics. Strahan and Hedt (2009) conducted an exploratory study to examine how teachers in an urban middle school learned to teach

more responsively through collaboration. That study documented ways that two seventh grade teachers, Richard and Jen, worked with a literacy coach and university partners to integrate reading and writing across the curriculum and to create connections with reluctant students during the 2007–2008 school year. Analysis of observations, interviews, and archival documents showed that professional growth accelerated with discussions of instructional practices and student performance, guided by informal assessments of student achievement. At the end of the year, students on their team showed growth on statewide achievement tests in both mathematics and reading, exceeding the expected growth set by the state and showing gains that were higher on average than the other seventh grade teams at their school.

Although the focus of the original study was the teachers' professional growth, the case studies conducted with individual students provided insightful glimpses into the ways students responded to their teachers' efforts to create connections with them. To examine the dynamics of differentiation in greater detail, Strahan and Hedt invited Richard and Jen to join them as members of an expanded research team. They also invited Jessy, a graduate student completing her teaching licensure and working as a tutor at the school, to join the team. This expanded team provided four different perspectives. Dave, a university researcher, served as lead investigator. Richard and Jen, the classroom teachers, offered the practitioners' insight and direction for the case studies. Melissa, the literacy coach, situated the results within the context of the school. Jessy, who worked with several of the students as a tutor, was able to function as a participant observer, interacting with students during lessons, taking descriptive notes, conducting interviews, and gathering work samples. In the fall of 2008, the research team analyzed the teaching and learning that occurred in a month-long interdisciplinary unit to describe instructional interactions related to academic content in greater detail. The team decided to focus on the construct of responsive teaching and adopted Tomlinson's (2003) definition of differentiation:

> Differentiated Instruction is responsive instruction. It occurs as teachers become increasingly proficient in understanding their students as individuals, increasingly comfortable with the meaning and structures of the disciplines they teach, and increasingly expert at teaching flexibly in order to match instruction to student need with the goal of maximizing the potential of each learner in a given area. (p. 3)

To investigate these dynamics systematically, the team decided to review the professional literature to identify essential variables, construct a logic model that might describe relationships among variables, test the model with data from the original case, and design a new case study to examine instructional interactions in the context of a specific unit.

Developing a Logic Model to Describe Responsive Teaching

In his analysis of case study research, Yin (2009) suggested that once exploratory cases have been completed, the propositions generated in those studies can guide subsequent studies to explain phenomena in ways that may inform practice more systematically. Propositions are essential to this process, as they "reflect important theoretical issues and direct researchers where to look" (p. 28). Yin noted that it may be possible to develop a logic model to provide sound explanations:

> The logic model deliberately stipulates a complex chain of events over an extended period of time. The events are staged in repeated cause-effect-cause-effect patterns, whereby a dependent variable (event) at an earlier stage becomes the independent variable (causal event) for the next stage. (p. 149)

One of Yin's hypothetical illustrations provided a starting point for conceptualizing this investigation. Yin described an intervention aimed at improving students' academic performance. This intervention created a new set of classroom activities, which provided time for students to work with peers (immediate outcome), which resulted in increased understanding and satisfaction (intermediate outcome), which produced increased learning of key concepts (intermediate outcome), enabling the "ultimate outcome" of higher test scores (p. 150).

Generating Propositions to Guide a Preliminary Logic Model

Interdisciplinary teaming that differentiates instruction has long been a central feature of the middle school concept. Early advocates proposed that teachers work together with the same students to create a safe and caring environment, one in which students could learn collaboration as well as content (George & Alexander, 1993). Since then, research has demonstrated that interdisciplinary team organization can benefit young adolescents (Arhar, 1997; Felner, Jackson, Kasak, Mulhall, Brand, & Flowers, 1997; Jackson & Davis, 2000; Mertens & Flowers, 2004;

Kuntz, 2005; Reed & Groth, 2009; Virtue, Wilson, & Ingram, 2009). Longitudinal case studies have chronicled ways that young adolescents can learn to think deeply and work collaboratively when immersed in supportive team environments (Kuntz, 2005). In classroom environments that offer varied lesson opportunities, students' learning differences have become strengths.

Research on differentiation has not been as clearly focused as studies of interdisciplinary teaming have been. As Carolan and Guinn (2007) noted, one widespread perception has been that differentiated practices are highly complicated: "Many educators mistakenly think that differentiation means teaching everything in at least three different ways—that a differentiated classroom functions like a dinner buffet. This is not differentiation, nor is it practical" (p. 44).

Carolan and Guinn examined the classroom practices of five middle school teachers who were considered by their colleagues to be experts in differentiation, observing some of their lessons and interviewing them extensively. Carolan and Guinn concluded:

> At the center of all five teachers' classrooms, we encountered strategies that addressed individual needs. Four common characteristics surfaced:
>
> - Offering personalized scaffolding.
> - Using flexible means to reach defined ends.
> - Mining subject-area expertise.
> - Creating a caring classroom in which differences are seen as assets (p. 45).

These four characteristics underscore Tomlinson's (2003) definition of differentiation as responsive instruction. In a general sense, teachers who are adept at differentiating instruction embrace individual differences, learn more about individual students as learners, and structure activities in ways that help students create connections with new information.

Two studies that have examined these dynamics empirically demonstrated some of the complexity inherent in applying these principles to practice. Van Tassel-Baska and her colleagues (2008) developed an instrument to assess the extent to which teachers demonstrated differentiated instruction and a parallel instrument to assess levels of student engagement in their lessons (VanTassel-Baska et al., 2003). Based on lesson observations conducted twice each year, researchers compared the classroom practices of 71 teachers in Grades 3–5 on measures of differentiated instruction. The 37 teachers in the experimental group participated in professional development focused on six aspects of differentiation. The 34 teachers in the comparison group did not. Results showed that "during this three-year language arts curriculum intervention study, experimental teachers continued to demonstrate higher levels of differentiated instructional practices than comparison teachers in all behavioral categories across both observations" (p. 306). Students in the classrooms of the experimental teachers demonstrated higher levels of engagement. Even so, very few lessons in either group demonstrated implementation of problem-solving strategies or research strategies. Anderson and Lee (1997) reported case studies of individual learning in two sixth grade science classrooms with teachers rated "exemplary" in teaching inquiry science. In settings with rich, varied instruction, students responded differentially. Anderson and Lee concluded that successful instruction "must start with understanding students' personal agendas and commitments, as well as their conceptions and learning processes in science" (p. 724). Students with dispositions toward inquiry were much more successful than students without these dispositions.

These studies have suggested that differentiation is an approach to teaching rather than a set of strategies, especially in regard to promoting engagement with ideas. In a synthesis of research on learning processes, Cross (1999) summarized much of what scientists have discovered about how people learn:

> Stunning new research on the brain by neuroscientists is adding a new dimension to our knowledge about learning that reinforces our previously tentative conclusions from cognitive psychology. This research provides growing evidence that learning is about making connections—whether the connections are established by firing synapses in the brain, the "ah ha" experience of seeing the connections between two formerly isolated concepts, or the satisfaction of seeing the connections between an abstraction and a "hands-on" concrete application. (p. 5)

In a subsequent analysis, Bransford, Brown, and Cocking (2000) emphasized the extent to which young people are problem solvers by their very nature and the important roles that adults play in nurturing these natural tendencies. Adults help young people make new connections, nurture curiosity, and encourage persistence by

- Directing their attention.
- Structuring their experiences.
- Supporting their learning attempts.
- Regulating the complexity and difficulty levels of information (p. 112).

Hammerness, Darling-Hammond, and Bransford (2005) concluded that responsive teaching results from a strong focus on students as individuals: "Descriptions of classroom practice suggest that some teachers eventually develop a strong focus on student welfare and learning that drives their teaching decisions and self-improvement efforts" (p. 379).

These guiding practices are especially important in helping students learn to think more deeply about content concepts. Smith and Colby (2007) examined middle grades students' levels of understanding in lesson materials from 64 teachers in 17 states. Researchers developed operational definitions of understanding at surface levels and deep levels to analyze lesson activities and corresponding student work samples with National Board candidates. Results showed distinct differences between lessons that emphasized learning at a surface level and those that encouraged deeper learning. "Here, the student focuses on relationships between various aspects of the content, formulates hypotheses or beliefs about the structure of the problem or concept, and relates more to obtaining an intrinsic interest in learning and understanding" (p. 206).

Interpreted together, these studies suggested three important propositions to guide the investigation of responsive teaching in the context of a differentiated, interdisciplinary unit:

1. Teachers create academic connections with students by learning more about them as individuals.

2. Teachers enrich academic connections with students by collaborating with colleagues to create more personalized instructional strategies and by scaffolding instruction to guide concept development.

3. Students' levels of understanding of academic concepts vary by the types of connections they make with teachers and with ideas.

Table 1 shows how research supported these propositions.

Working from these propositions and Tomlinson's (2003) essential definition of differentiation as responsive teaching, researchers generated a logic model to use in reanalyzing data from the original cases (Strahan & Hedt, 2009). Figure 1 presents the logic model the authors developed to guide this reanalysis. They hypothesized that the process would begin when teachers made conscientious efforts to *learn more about students as individuals.* Using this information, teachers would then work together to enrich academic connections with students by *creating more personalized instructional strategies and scaffolding instruction to develop concepts.* As a result of these "interventions," students would then *engage in lesson activities and make connections with other people and with ideas.* These intermediate outcomes would then result in *students demonstrating higher levels of reasoning.*

Re-examining 2007–2008 Case Data Using the Logic Model

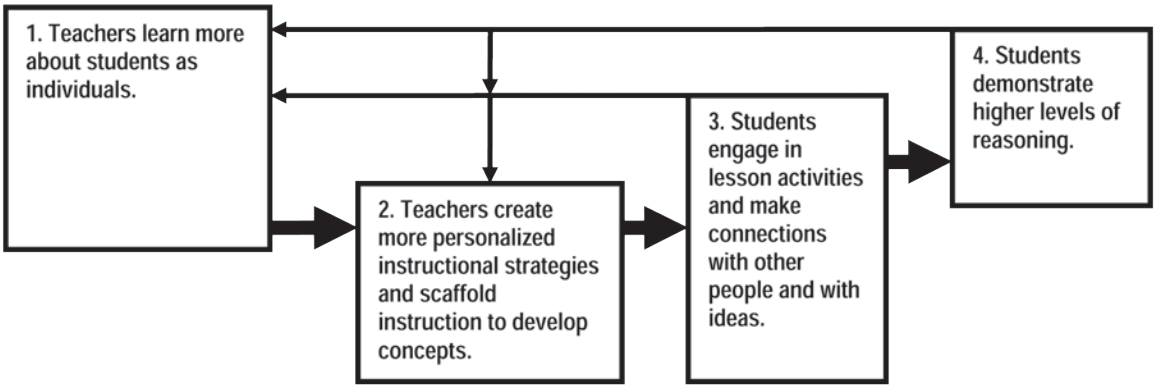
Using the logic model, researchers re-read each of the individual case reports from 2007–2008 and identified ways that Richard and Jen put these general dynamics into practice. This analysis resulted in several revisions to the logic model. Case reports showed that to set the stage for *learning more about students as individuals*, Richard and Jen made a conscious effort *to create classroom learning communities.* From the first days of school, they worked together to promote shared responsibility for learning. As Richard suggested, "We have managed to stay positive and not let the dangerous attitude of 'It's not cool to be smart—it's not cool to be motivated by school' get started" (Strahan & Hedt, 2009, p. 10). In regular dialogue sessions, he and Jen collaborated "to get students to accept the fact that they need to come into the classroom and give it their best shot" (p. 7). By modeling positive interpersonal dynamics with students and with each other, they invited students to trust them and trust each other.

Having created a more positive climate for learning, Richard and Jen were then able to plan activities and discussions that helped them *learn more about their students as individuals.* They worked together to develop a sophisticated set of formal and informal assessments. Using data from informal weekly assignments and from the district's benchmark tests, they collaborated with Melissa to develop a system for monitoring individual performance. They created a portfolio of work samples in which students did a math or science activity and incorporated

Table 1
Propositions from research on responsive teaching

Propositions from research	References to studies of responsive teaching
1. Teachers create academic connections with students by learning more about them as individuals.	Anderson and Lee (1997) Effective instruction • "Must start with understanding students' personal agendas and commitments as well as their conceptions and learning processes in science" (p. 724).
	Hammond (2007) Effective programs aimed at promoting school completion • Focus on building students' relationships with teachers, parents, and peers. • Include systematic monitoring of the students' performance. • Work to develop students' problem solving skills. • Provide opportunities for success in schoolwork. • Create a caring and supportive environment. • Communicate the relevance of education to future endeavors, and help with students' personal problems (pp. 7–8).
2. Teachers enrich academic connections with students by collaborating with colleagues to create more personalized instructional strategies and by scaffolding instruction to guide concept development.	Carolan and Guinn (2007) Successful teachers • Offered personalized scaffolding. • Used flexible means to reach defined ends. • Mined subject-area expertise. • Created a caring classroom in which differences are seen as assets (p. 45).
	Tomlinson (2003) • Differentiated Instruction is responsive instruction. It occurs as teachers become increasingly proficient in understanding their students as individuals, increasingly comfortable with the meaning and structures of the disciplines they teach, and increasingly expert at teaching flexibly to match instruction to student need, with the goal of maximizing the potential of each learner in a given area (p. 3).
	Bransford et al. (2000) Children's curiosity and persistence are supported by adults who • Direct their attention. • Structure their experiences. • Support their learning attempts, and regulate the complexity and difficulty levels of information for them (p. 112).
3. Students' levels of understanding of academic concepts vary by the types of connections they make with teachers, classmates, and information.	Cross (1999) • Learning is about making connections—whether the connections are established by firing synapses in the brain, the "ah ha" experience of seeing the connections between two formerly isolated concepts, or the satisfaction of seeing the connections between an abstraction and a "hands-on," concrete application (p. 5).
	Smith and Colby (2007) • A deep approach to learning involves an intention to understand and impose meaning. Here, the student focuses on relationships between various aspects of the content, formulates hypotheses or beliefs about the structure of the problem or concept, and relates more to obtaining an intrinsic interest in learning and understanding (p. 206)

Figure 1
A preliminary logic model for creating academic connections through differentiation



writing. During lessons, they engaged in habitual "kidwatching," a process Jen described as "just visually seeing the difference in the kids' attitudes in what you are doing. When the piece of the puzzle falls into place for them, it is really obvious in how they approach the product" (Strahan & Hedt, 2009, p. 8). Using their knowledge of students, Richard and Jen were then better able to *personalize instruction and scaffold instruction to develop concepts* by *drawing from a "main menu" of instructional strategies to respond to the needs of groups and individuals.* The strategies they shared in the year-long case study and used most frequently included essential vocabulary, inquiry activities, and content journals with personal reflections.

These three major interventions—creating classroom learning communities, learning more about students as individuals, and drawing from a main menu of instructional strategies—resulted in the first major outcomes: *Students engaged more intensely in lesson activities and made stronger connections with content.* Richard and Jen designed lessons that scaffolded instruction and taught strategies explicitly. As time progressed, students began to make connections with other people and with ideas. In the case studies, students expressed their highest levels of interest in hands-on activities like labs and were most engaged in collaborative learning. For example, Shari reported that her favorite kinds of assignments were science labs and social studies simulations and that she enjoyed working with partners. Her involvement in the book groups was "one of the most helpful parts of school because it helped her gain confidence in her reading abilities" (Strahan & Hedt, 2009, p. 11). Case study students articulated personal connections with concrete lesson activities, especially when asked to generate their own applications. After a lesson on ways of life in tropical Africa, Tonya recommended that she and her classmates write letters to the people in Africa, "like Ms. A's old students. We could write to them saying we see how it is for them, we could tell them how we feel. Maybe we could do something for them instead of just watching them suffer" (Strahan & Hedt, 2009, p. 12). These immediate outcomes, students engaging in lesson activities and making connections with other people and ideas, enabled "ultimate outcomes" in which students demonstrated higher levels of reasoning, producing the "secondary outcome" of growth on achievement tests at the end of the year.

Researchers expanded the logic model to incorporate these descriptions. Figure 2 presents the revised logic model.

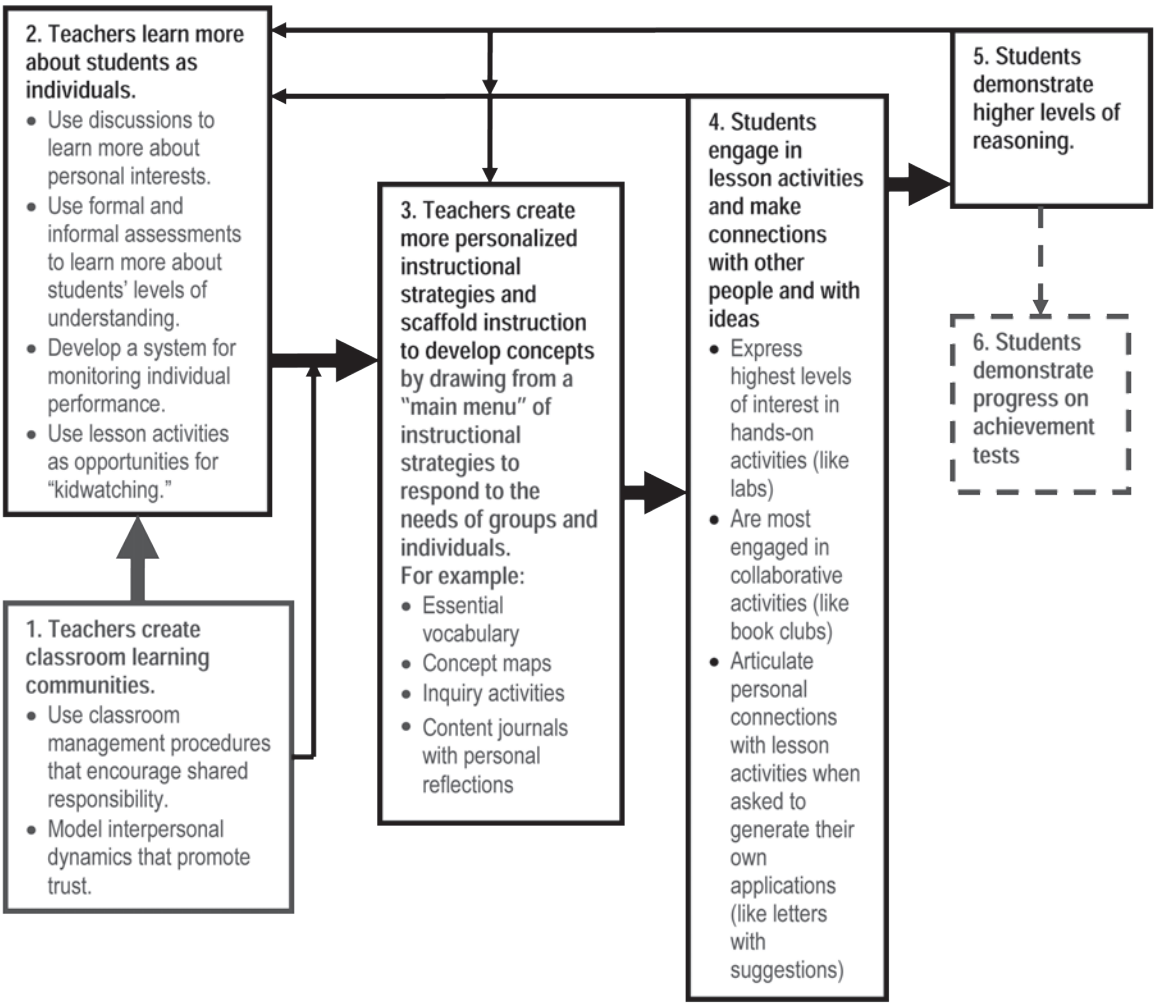
Working from this revised logic model, researchers and teachers designed a case study to examine ways Richard and Jen differentiated instruction and ways students responded during a month-long interdisciplinary unit. Two questions guided this investigation:

1. How do teachers design a differentiated, interdisciplinary unit that attempts to create academic connections with students?
2. How do students' understandings of concepts relate to connections they make with teachers, classmates, and ideas?

Methodology for the 2008–2009 Case Study

The 2008–2009 study focused on ways Richard and Jen differentiated instruction. More specifically, researchers examined ways five selected students

Figure 2
An expanded logic model for creating academic connections through differentiation



responded to teachers' efforts to create connections with them and engage them more fully in lessons. Central City Middle School provided the context for this study. A school in a small southern city, Central City serves just over 600 students, 35 percent of whom are members of minority groups and 45 percent of whom qualify for free and reduced-price meals. During the 2008 fall semester, the seventh grade teachers at Central Middle School worked collaboratively to develop and implement an interdisciplinary unit entitled "Hungry Planet" that would integrate concepts from science and social studies with learning strategies using technology. Researchers selected this unit as the focus of the study so that students' development of concepts could be situated in the context of specific content.

At the end of the first grading period, teachers identified five students who represented a range of academic performance and who had demonstrated varied approaches to instructional activities. Richard and Jen invited Juan to participate in the study because they knew he was especially interested in learning about other countries. His family had recently moved to the area from Latin America, and he seemed curious about other cultures. He was almost always engaged in lessons and eager to participate. Liz was also a good student, although she was often not as overtly engaged with lessons as Juan was. Jen noted, "She will push away the intellectual side of herself to look cool." Teachers asked James to participate, as they were sometimes perplexed by the inconsistencies in his engagement. In some lessons, he was focused and inquisitive. Other days, he seemed disinterested. Activities that included pictures or manipulatives especially appealed to him. Mariah was also a bit of an enigma, occasionally demonstrating moments of keen insights while often submitting incomplete work or appearing distracted.

In contrast to the other four, Michael seemed to struggle with many lessons and rarely engaged with lesson activities.

Researchers obtained consent from these students and their parents to participate in a study of their responses to instruction. To examine ways students learned central concepts, researchers observed lesson activities, analyzed work products, and interviewed students. During the Hungry Planet unit in November, researchers observed nine of the 20 lessons Richard and Jen taught. For each lesson, they took notes describing lesson activities and the responses of the five individual students to these activities. After each activity, they conducted "debriefing" interviews with each student using the following protocol:

1. Please tell us about this assignment.
2. How difficult do you think this assignment was (or will be)?
3. Do you think this assignment is interesting? Why or why not?
4. (For completed assignments) Describe what you did, the steps you took to complete this assignment.
5. (For new assignments) Describe what you will do to complete this assignment (Describe the steps you think you will take.).
6. What goals have you set for yourself in this class?
7. Are you reaching goals that you have set for yourself in this class? (Why or why not? Please include the goal in your description.)

Researchers created individual case studies with the five selected students to document their levels of understanding and the nature of personal connections they made with lesson activities. For each of the five students, the team analyzed four central work samples related to the Hungry Planet unit: (a) the science lab summary, (b) math charts and graphs, (c) the final integrative concept map, and (d) the concluding essay.

To describe students' understanding, researchers analyzed work samples and related student interviews in a recursive fashion, repeating rounds of analysis until they identified key concepts and shared responses. They agreed that Juan clearly articulated a sophisticated understanding of all the concepts. Using his case as a benchmark, researchers analyzed the responses of the other four students independently and then compared their results. After agreeing on an overall description of each student's understanding, the researchers reexamined work samples and interviews to identify ways students articulated connections they made with the concepts. They then constructed narrative case summaries for each student that integrated expressions of understanding with the descriptions of the types of connections students made with concepts and activities. To examine the accuracy of the logic model, they drafted a cross-case analysis that compared and contrasted patterns of connections and understanding.

At this point in the process, they enlisted an external reviewer to examine the individual cases and to assess the quality of the cross-case analysis. Experienced in qualitative research but unfamiliar with the teachers and students, the reviewer provided a fresh perspective and assessed the draft report using Yin's (2009) "principles of good social science research:" attending to "all evidence," addressing "rival interpretations," addressing the "most significant aspects" of cases, and using current thinking about the case study topic (pp. 160–161). The external reviewer reported that individual cases and cross-case analysis represented the evidence well and addressed rival explanations. He questioned the significance of attempts to integrate conclusions from the cases with reference to end-of-grade achievement tests, however. The authors agreed with his concerns and eliminated those references when preparing this final report. The sections that follow present summaries of individual cases and the revised cross-case analysis.

Results

Teachers' Development of the Hungry Planet Unit

During the month of November 2008, Jennifer, Richard, and the other seventh grade teachers at Central Middle School implemented a unit they planned to explore world hunger, its causes, and its solution. This month-long, integrated, multi-disciplinary unit was guided by five main themes that were linked to world hunger through lessons in math, science, language arts and social studies: nature, education, economics, population, and politics.

Teachers designed an introductory activity featuring a video of graphic images of human hunger around the world, a speaker from a local food bank, and a presentation on the work of Doctors without Borders in countries afflicted by hunger. The discussion about Doctors without Borders took the form of a Paideia seminar and introduced students to the Bracelet of

Life—a paper bracelet used to determine the level of malnourishment experienced by a patient. Students were given a Bracelet of Life, first, to guess what its purpose might be in relation to doctors working with malnourished patients and, second, to use on themselves to make the comparison between their level of health and that of the malnourished.

In their social studies classes, students used the book *Hungry Planet* (Menzel & Daluiso, 2007) to learn about food consumption trends in a variety of countries around the world. Several math and technology lessons focused on the 2007 World Population Data Sheet produced by the Population Reference Bureau. Students worked in groups to make graphs of the information. The World Population Data Sheet was also the basis for a related technology lesson. Students went to the computer lab (or worked on classroom laptops) to learn new spreadsheet skills in Microsoft Excel. In their language arts and social studies classes, students learned about the genocide in Sudan and how it related to hunger. With the details they learned from their articles, students completed a writing assignment related to the Sudan. The basic assignment was to create a graphic organizer including categories such as government and geography. More advanced assignments required a letter to the United Nations including statistics and a solution to the problem or a letter to a celebrity to convince him or her to organize a charity event to benefit the Sudanese refugees.

One science activity for Hungry Planet was a lab activity that explored moisture levels in the soil and involved the use of high-end technology (i.e. laptop computers, specialized software, and computer-based temperature sensors). This lab lesson concluded with a discussion about the difference between the dew point temperature they measured locally and the dew point in North Africa and how the climate of a place can affect food production possibilities, thus contributing to a food shortage.

Another Hungry Planet lesson took students to the Media Center for a scavenger hunt. One station included copies of the *Hungry Planet* book, which they used to find information about meat consumption, comparisons of food and families in various world regions, and statistics on overweight people as well as others. Another station provided an almanac, encyclopedias, and a dictionary for students to answer questions about populations and natural disasters. The final station provided students a globe and atlas to answer questions about world and local geography.

The Hungry Planet unit concluded with a closing Paideia seminar. Students viewed a photograph of a city and made observations of its contents. They shared their observations and then were presented with a second photo to observe. This photo was an image of an adult and children, possibly a family, collecting or scavenging in what looks like a large pile of rubble along a river. Students shared their observations and were asked which location they would like to live near and what the focus of each photograph seemed to be. Students then put the photographs together to see that they were really one image cut into two. The seminar ended with the questions, "How do these photos relate to our study of hunger during Hungry Planet? And, what are specific actions we could take at school, at home, or in our communities to help end poverty?"

The final assessment of this unit began with a pre-writing assignment. Students created a concept map that linked hunger to the guiding themes of the unit: economics, politics, population, education, and nature. They then connected two of these guiding themes to each other using what they knew about the themes and hunger. The final assessment was a writing task in which students wrote to the United Nations to present a plan to solve world hunger. Their plans were to be supported by information they learned during the unit and were to include details such as the necessity for their plan and its logistics.

These collaboratively planned activities provided Jen and Richard with a framework for personalizing instruction and scaffolding assignments more responsively. As the unit progressed, each of them made several adjustments during the flow of lessons. After she introduced the lesson on Sudan, Jen incorporated a simulated "walk to a refugee camp in a high state of malnourishment" to give kinesthetic learners a chance to move. She asked students to walk as though they were protein deprived. After this walk, she led a discussion about atrophied muscles and the importance of protein in brain function—making connections with the science curriculum. She also explicitly implemented reading strategies for use with passages from the *Hungry Planet* books, encouraging students to compare details regarding packaged versus non-packaged foods from around the world. Richard decided he needed to take time after the dew point lab to review the first page of lab packet with the class and to discuss differences between the climates of Asheville and Africa in relationship to food growth. After the lab, Richard showed a United Streaming video on dew point and humidity. "It was short and they watched it twice to be sure we all

understood the connection between dew point, the lab, and climate in Africa."

Student Case Summaries

Juan. As his teachers had predicted, Juan seemed to enjoy almost everything about the Hungry Planet unit and was eager to share his insights in interviews. In each of his assignments and interviews, he articulated an integrated understanding of the concepts explored. Not only did he make connections between hunger and the guiding themes of this unit (i.e., nature, education, economics, population, and politics), he also related these connections to other learning experiences beyond the unit. Juan's work samples and interviews provided illustrations of his ability to pull information from a variety of sources to help make sense of hunger issues . In relating hunger to economics, Juan stated:

> For economics, I related to what we were talking about in Ms. Doherty's class about colonialism. We just talked about the Berlin Conference. It relates economics and hunger. The Africans couldn't get all their raw materials, like iron and diamonds, because the Europeans took it all and made money off of it. This would make them poor and hungry. I think homelessness and charity are also related to economics.

After the discussion regarding genocide and hunger in Sudan, Juan said, "In Darfur there are limited resources at the refugee camps, and if you are fleeing to one of these camps, you can't get a lot of food." Juan's writing assignment for this lesson was to create a persuasive letter to a celebrity and encourage him/her to organize on a concert to benefit the Sudanese refugees. Juan was highly engaged in this process:

> I really enjoyed writing to a band because I got to choose a celebrity. I liked that part a lot. I liked, too, that we got to choose the content of the letter. It was like we had more freedom with this. It was fun to take the information from the article and put it somewhere, not just keep it in my brain. Now I could go back to it and remember the facts.

Juan was also highly engaged during the science lab related to the Hungry Planet unit. He explained, "It was really fun. I liked all the technology we got to use. We measured readings of temperature, and we learned about climate. … I learned for it to affect hunger, the climate of a place would have to have low dew point."

Although his comments in interviews often focused on language arts and social studies lessons, his writing assessment paid great attention to the relationships between hunger and science. The solution he proposed to the United Nations was to make an artificial seed for food so that food will grow in any climate. He used the historical example of rot-resistant rice in China to justify his plan for the world's top scientists to develop other crops that can withstand the forces of nature and survive in any climate. Juan not only considered climate science in his plan, he also included concepts from the study of genetics. He linked this plan to the need for fund-raising and United Nations funding. He suggested global fund-raisers that involve school children from around the world making small donations—"The money may not seem like a lot, but it will add up, especially if we get schools from lots of countries."

At the end of the unit, Juan expressed appreciation for the ways his teachers had helped him learn more about collaboration:

> They would break us up into groups so we could help each other too. For projects we'd be in different groups too. I like groups sometimes, but it depends on the group—I'd rather work on my own sometimes. Though, it has happened that, working in a group, I got help on something that I didn't know how to do.

Liz. Although not as forthcoming in assignments and interviews as Juan, Liz also clearly identified relationships between the components of hunger and recognized their significance in terms of a whole concept. She consistently examined facts to create larger ideas; she then linked these ideas to each other to create meaning of a more complex concept.

Initially, Liz's connections were somewhat superficial. However, when given time to think about a concept, she connected big ideas in a more profound manner. Summarizing was more difficult for her than linking facts. She thrived when she was researching, especially when the search involved numbers from a chart, as opposed to information in a book. Liz excelled at interpreting numbers organized in a table and giving them meaning. When evaluating lessons, Liz focused her judgments on the lessons' structure and content. It was clear to her which lessons were of highest interest and provided the most challenge to her.

Throughout the Hungry Planet unit, Liz used the general concept of world hunger as an organizing construct for interpreting facts. For example, when talking about her concept map for Hungry Planet, she stated:

> I tied together nature and politics because the genocide in Sudan affects the natural environment. Entire towns are burned and destroyed by the Janjaweed (who are supported by the government). If the towns are ruined, then there is no way to grow food, because you can't grow on bad land.

At times, the initial connections Liz made about facts she learned during the Hungry Planet lessons were basic, though she often was able to expand her thinking on these ideas. Liz responded to the lesson with the World Population Data Sheet by saying:

> [It] was interesting because it was fun to work with the numbers and charts. We only chose one region to make the charts, but we looked at a lot of them to make our choice. It was cool to see all the differences. … I liked looking for information, instead of just writing it down. … I felt like I got a lot out of it because there was so much information to see. It was challenging because it took a long time. It was important to see things like life expectancy; some comparisons were surprising, too.

Liz's highest interests occurred in lessons that encouraged emotional response—or that provided an emotional response from her classmates. In conversation during the final seminar, Liz explained her observations of the photos. She saw extreme poverty on one side of the river and rich people on the other side. "We have this too in our country," she said. She later explained, "There are people here who have nothing; it's not just in other countries. It is like in Washington, DC—there you have the government right next to homelessness. You see homelessness in Asheville, too." This lesson sparked a connection to a prior assignment, the letter to a celebrity regarding Sudan.

Liz's final writing assignment clearly articulated an understanding of solutions to world hunger. Her persuasive letter made connections among solving world hunger and volunteerism, use of statistics, corporate donations, and nutrition. Liz's plan involved circulating portable markets throughout regions afflicted by hunger. To determine the places to which these markets would travel, she explained, "I would find the percent of impoverished families in different villages and place the markets in the places that need it most." Liz understood that supporting her plan with these types of statistics would be a persuasive strategy in presenting the UN with her solution.

At the end of the unit, Liz expressed appreciation for the way her teachers varied instruction:

> Well, we didn't just read books about things. We watched things too, like videos, and used computers. The technology helped me out a lot. It's interactive ,and that is good for me. It was good to watch exciting stuff on the videos and not just read about it. Also, like Ms. D would let us make crafts that went with new ideas and stories we learned about. We weren't just reading about the new things—we did it! Like we read folk tales then made our own.

Jen noted, "She will still push away the intellectual side of herself to look cool, but she can be encouraged out of that. She doesn't always like to be seen doing the work—doesn't want to be thought of as uncool—but she still wants to do it."

James. James engaged with lesson activities in the Hungry Planet unit more consistently than he had in previous units. His connection-making ability grew more sophisticated as the lessons progressed. He was clearly able to connect ideas of hunger with other themes, like nature and population. However, his connections were limited, in that he did not link them to each other. Though he was able to generate meaningful insights, he rarely articulated relationships among ideas.

James excelled at comparing numerical data and making meaning from numbers. It was his preference to organize data in charts, make calculations, and then draw meaning from this data. James was capable of deep thought, but not consistently. He made connections on his own, but it could take him a long time to get to that point, and, at times, even superficial connections were difficult for him to attain.

Some of the clearest connections James made were at the end of the unit when he worked on a graphic organizer to relate hunger and the guiding themes of the unit. He compared information he found working with the World Population Data sheets about the populations of certain countries and the "percent hungry" in those countries. Then he calculated the number of hungry people in each country using

this information. His reflection on this part of the assignment was as follows:

> I used the data sheet with all the numbers on it. I made it connect to hunger because there was a column that was, like, 'percent of hungry people.' I used that to compare it to the whole population of a place. I thought it was, like, using facts mainly. But it also makes a connection to hunger because of those percents.

In his final writing assignment, James proposed a solution for world hunger to the UN. His writing identified several important connections to world hunger, though it did not link these to each other. His idea connected corporate donations to a solution for hunger. Additionally, he was able to connect ideas of basic needs in suggesting providing shelter for those in need as well as food. However, his focus on shelters detracted from his solution to world hunger and showed a disconnection in understanding. His plan included requiring occupants to pay and work to stay in the shelters, largely overlooking the significance of world hunger and the circumstances in which it exists.

The inconsistencies of James's reasoning on the Hungry Planet unit, as well as on other lessons, led teachers to investigate his work patterns more closely. They encouraged one of the teacher assistants to spend more time with James during the flow of lessons. This assistant worked with James during group assignments and occasionally pulled him aside for one-to-one support. In an interview toward the end of the year, she noted:

> I try to follow Jen's example of being very fair and as consistent as possible. James was motivated when he wanted to be—and had his days when he's uninterested in everything. He can also be very focused. Anything visual really helps him. The integration of visual elements seems to make a big difference for him.

When asked to share perceptions of James and his work, Jen and Richard noted that the individualized support he received from Ms. J helped him to simplify big ideas into smaller parts that were more digestible for him academically. Jen recalled that James thrived on classroom participation and being called on during class. "He's one of the few students who really enjoyed preferential seating. He enjoyed sitting in the front and being close to the action. He worked very well with anything visual—it seemed to tap into the artist in him; anything art-based he connected with."

When asked to reflect on his experiences, James expressed appreciation for the way Richard would "always help with simplifying things. We studied as a class, and he would give us some easier ways to do problems." He added that his teachers gave him "a lot of one-on-one help and would help me after school. They have done a lot of things to show me they care."

Mariah. Like James, Mariah was more consistently engaged with Hungry Planet activities than she had been with earlier units. Although her recall of tasks and activities was very detailed, she rarely made connections between these elements. When pushed to connect ideas with more complexity, her reasoning often faltered and she grew frustrated. She did not often show evidence of deep thought and would try to make sense of something new to her by relating it to her own personal experience.

Her reflections on lessons often focused on activities. After the dew point science lab, for example, Mariah described the procedure of the experiment, the equipment used to complete the experiment, and explanations her teachers supplied to help guide students through the experiment. She used vocabulary such as "temperature," "minimum temperature," and "10.5 degrees Celsius," to describe the activity. Although her recollection of detail was precise, she made few connections between the concepts of dew point and hunger.

Mariah made stronger connections between the concepts of hunger and dew point at the end of the unit. On her graphic organizer, Mariah wrote, "If the soil is not rich enough and the rain is not heavy enough to produce food, people cannot get food." She reflected on this statement by saying, "I thought of this because we talked about different places that try to grow food and why it is harder in some places than others. The soil really matters." Her letter to the United Nations proposing a solution to world hunger displayed some elements of creative thinking. She proposed fund-raising events to benefit the hungry and described the logistics related to her plan. She thought of which countries she would send food to and how she would get it there. Her solution focused solely on her efforts as an individual solving world hunger on her own, however, and did not clearly link together the connections she made.

Mariah's varied responses to activities led her teachers to spend more time with her individually. Richard noted, "For math, it was always a bit of a mystery that she did as well as she did. I just had to trust she understood it all when she said she did." Jen

recalled, "We knew we had to put her with the person she knew best in the class or she'd just shut down; she's shy like that." Jen learned that Mariah often tried to hide her reading ability from her friends:

> It was seen as not cool to read, but she found ways to get it done. One reason she improved her reading so much is that she is a secret reader. I learned not to talk with her about books in front of other students. She is super shy. If we offered to work with her during class, she would say "I don't need help." I found that if I talked with her off-stage, she loved talking about books. I ordered a few things just for her and made sure she got to keep them.

When asked, "What were the most helpful things your teachers did?" Mariah's responses included "Ms. D would help us learn things using videos and making us do big projects. Mr. B put things on the board and walked us through problems, then gave us some problems to work on our own or, like, in pairs, which would help me. They would check in on us when we worked alone and answered questions, gave us more time, too, if we needed it."

Michael. As he had with earlier lessons, Michael struggled to make basic connections between hunger and the themes of this unit. Michael could remember factual information from lessons, though he sometimes required guidance for this recall. Although Michael occasionally would relate topics to his personal experiences, he often displayed difficulty in comprehending new ideas. For example, when asked to reflect on the dew point science lab, Michael explained the connection between this lesson and hunger by saying, "Maybe the connection to hunger is to see how cold it is to see if food could freeze."

While Michael's responses to interview prompts and the work he produced often revealed disconnected information fragments, he began to demonstrate more integrated thinking on his final essay. His persuasive letter to the UN presented the basic ideas that, to solve world hunger, one must think beyond his own needs and that volunteerism can play an important role in the solution. He stated, "I hope we can do something about world hunger. I hope people stop thinking only about themselves, " and, "Just take time out of your time and go give somebody that need it your time and spend a day with them." Michael's solution to world hunger also involved the volunteer construction of places like "Ingles, Wal-Mart, and Dollar Store so people who are starving would have somewhere to buy food." He also stated, "We can go over there and build places where they can go out to eat with their family and friends." Although he was able to connect the larger ideas of selflessness and volunteering to the concept of world hunger, his solution to build restaurants so that hungry people can go out to eat with their friends exhibited a lack of understanding of the complexity of the problem.

In the weeks following the Hungry Planet unit, when Jen and Richard met with researchers to discuss the cases, they often expressed concern that Michael was not making many connections with new ideas and asked Jessy to work with him on an individual basis. During the spring semester, she met with him weekly and conducted an additional set of 10 observations and interviews with him. An entry from her researcher's log provides a useful summary of his responses to lessons during the third nine weeks:

> It is important to note elements of Michael's personality beyond his general academic performance to obtain an accurate image of him as a student. Michael is often quick to respond to a question with "I don't know," then immediately answer the question or solve the problem correctly. It is unclear why he does this. His teachers think it might be a strategy that has worked for him in the past at getting attention or something else he desires, because he expresses this behavior regularly. He feigns ignorance then displays full understanding. He is a difficult puzzle in this sense. (Researcher's log, February 26, 2009)

In individual work sessions with Jessy, Michael began to demonstrate greater awareness of his needs as a learner. He readily identified the types of questions that challenged him most and spent more time reflecting on his responses.

Cross-Case Analysis and Revisions to the Logic Model

To examine the accuracy of the revised logic model (Figure 2), researchers tested the model with descriptions of instruction during the Hungry Planet unit and with each of the five student case studies. Data suggested that steps one, two, and three of the model provided a clear working description of the ways Richard and Jen planned and taught the unit. Student comments in interviews supported the prediction that the teachers would *create classroom learning communities* that encouraged shared responsibility and promoted trust. As they did so, the

teachers *learned more about students as individuals.* In the lessons they planned for the Hungry Planet unit, Richard and Jen *drew from a main menu of instructional strategies to respond to the needs of groups and individuals.* They stressed essential vocabulary; integrated math with science, social studies with language arts; created inquiry activities; incorporated Socratic dialogue into activities; used concept maps; encouraged reflective writing in content journals; structured peer collaboration; and integrated digital learning projects.

Lesson observations and student interviews documented general patterns of engagement similar to those predicted. Each of the five students was highly engaged with at least three of the lesson activities in the unit. Each made connections with new information, articulated some relationships among ideas, and expressed intrinsic interest in at least one aspect of the unit. Engagement varied considerably, however, with Juan, Liz, and James engaged more often than Mariah or Michael.

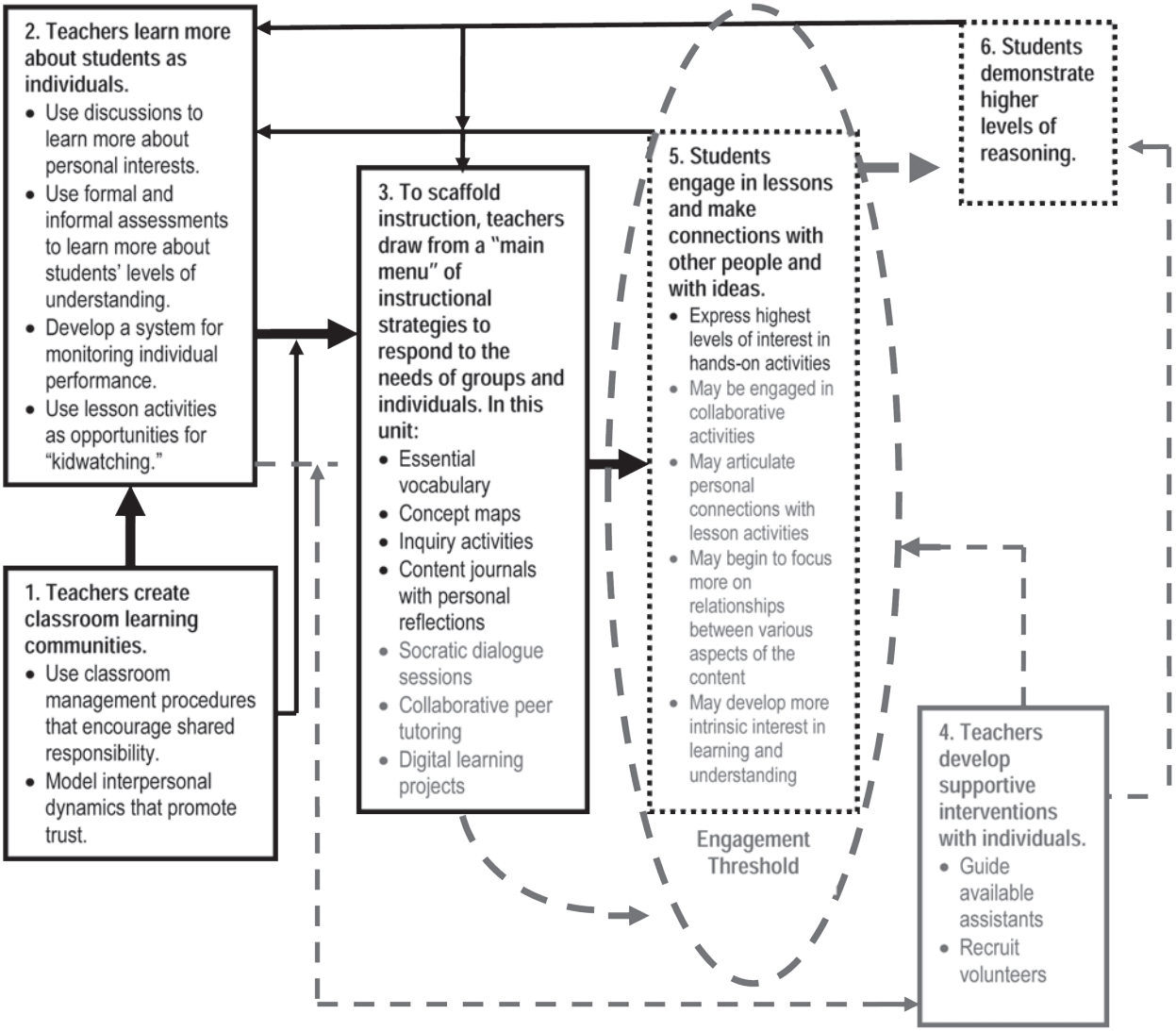
All five students demonstrated higher levels of reasoning related to the five guiding themes of the unit: economics, politics, population, education, and nature. Two students made deep connections. Juan developed an abstract conceptualization of concepts, expressing ideas in his final essay that integrated information from the unit with his own personal hypotheses related to reducing hunger through biotechnology and transportation. Liz articulated concepts in a fashion that demonstrated strong integration of information. She readily identified relationships among components of hunger and recognized their significance as a whole concept. The other three students expressed connections in ways that showed growth. James was able to report essential ideas. Mariah approached integration in her final essay. Michael grew from a limited understanding of concepts to a clearly articulated representation of one cluster of ideas.

In a general sense, then, data supported the logic model as an explanation of the dynamics of responsive teaching. As Yin (2009) suggested, however, the purpose of a logic model is to "stipulate a complex chain of events over an extended period of time" (p. 149). In this regard, the proposed model was accurate yet incomplete, especially in regard to engagement and achievement. As noted earlier, engagement varied by student, and some students were more successful in developing high levels of reasoning from their engagement. Juan and Liz made more connections with information and processed it more deeply. Their connections were more personal. James, Mariah, and Michael made some personal connections, learned some new information, yet did not integrate connections into deeper levels of understanding.

To improve the power of the logic model, researchers made three major revisions (see Figure 3). To explain the variability of engagement, researchers hypothesized an *engagement threshold.* Depending on the strength of the connections they created with teachers, classmates, and information, students crossed a threshold that permitted them to engage more frequently in lesson activities. To benefit from lesson activities, students need to invest mental energy in the task. When this happened, as it did for Liz in the analysis of data related to Ethiopia, and for James in the lesson on genocide in Sudan, students made powerful connections with their own prior knowledge, with new information, and with their emotional responses. Mariah approached this level of engagement with the introductory video, and Michael with his graphic organizer. To incorporate this dynamic of an engagement threshold into the logic model, researchers qualified each statement with the word "may" to emphasize variability; replaced the solid line surrounding the engagement diagram with a dotted line; surrounded it with an oval with open spaces, to signify the engagement threshold; and added a variable connector to the main menu of instruction.

As they reflected on students' work on the Hungry Planet unit, as well as their other assignments, Richard and Jen realized that James, Mariah, and Michael needed more personalized support. They asked Ms. J to work more intensively with James and guided her in focusing on using his talents for art to make more specific connections with concepts. They recruited Jessy to work intensively with Michael and encouraged her to help him gain more awareness of his thoughts while he was working. Jen worked individually with Mariah on reading. To incorporate this dynamic into the model, researchers added a fourth teacher box: *Teachers develop supportive interventions with individuals in which they guide available assistants and recruit volunteers.* To improve the accuracy of the chain of events within the model, researchers added arrows to connect the development of interventions with learning more about students, drawing from a menu of instructional strategies, and demonstrating higher levels of reasoning. They replaced the solid arrow

Figure 3
A Logic Model for Creating Academic Connections in an Interdisciplinary Unit



connecting engagement and reasoning with dashes to suggest a more indirect relationship. As these types of thinking were not directly assessed in state-mandated achievement tests, researchers deleted the link to achievement test scores from the final model.

Conclusion

The revised logic model describes more specifically responsive teaching as it occurred in Richard and Jen's classrooms during the Hungry Planet unit. Lesson observations, interviews with students, and analysis of work samples documented a process of differentiated instruction that encouraged students to make stronger connections with information. As Anderson and Lee (1997) noted, their responsive teaching started "with understanding students' personal agendas and commitments" (p. 74). They regularly offered personalized scaffolding, used flexible means to reach defined ends, mined their subject matter expertise, and created caring classrooms in ways very similar to the teachers described by Carolan and Guinn (2007). They personalized instruction by developing supporting relationships with and among students and by guiding them in making connections with information (Hammond, 2007; Tomlinson, 2003).

Students in these case studies demonstrated levels of understanding of academic concepts that varied by the types of connections they made with teachers and information (Bransford, Brown, & Cocking, 2000; Cross, 1999). Juan and Liz achieved deep levels of understanding in the Hungry Planet unit. They

focused on relationships between various aspects of the content, formulated hypotheses, and developed intrinsic interest in learning and understanding (Smith & Colby, 2007). Consequently, they were able to articulate insightful and original suggestions for alleviating world hunger that reflected connections among concepts related to economics, politics, population, education, and nature. Although they did not accomplish such deep levels of understanding, James, Mariah, and Michael demonstrated growth in comprehension. They processed information related to concepts, learned new terminology, and expressed personal connections with ideas. Throughout the unit, they strengthened these connections, demonstrating higher levels of reasoning, which progressed from understanding information in isolation toward more integrated comprehension.

To interpret these results most productively, researchers must consider the limitations of this study and situate the findings in the context of teachers collaborating with researchers to study their own practice. To examine students' reasoning in reference to specific subject matter, the team decided to focus on student responses to one unit of instruction. Students shared insights on their learning in this setting. While one could logically infer that students' reasoning continued to develop through the following semester, it is important to must remember that students' comments were time bound. The team chose to study five students to explore individual responses in depth. Because generalizability is limited, it is impossible to trace causal connections among the immediate outcomes of engagement, ultimate outcomes of reasoning development, and secondary outcomes of achievement.

Tomlinson's (2003) definition of differentiation as responsive instruction provided a framework for this investigation, as did general descriptions of differentiation as three intertwined processes: embracing individual differences, learning more about individual students as learners, and structuring activities to help students create connections with new information. As straightforward as these dynamics seem to be, previous case studies have demonstrated that they grow complicated in practice (Anderson & Lee, 1997; Van Tassel-Baska et al., 2008). Although limited in time and scope, this study may illuminate some of these interactions. Working from a unit plan with rich and varied activities, Jen and Richard were able to interpret students' responses, adapt lessons, and nurture engagement more productively. They identified the structure of students' thoughts in reference to the concepts emphasized in the Hungry Planet unit. As they did so, they helped them extend their current understandings to accomplish deeper levels of comprehension. By documenting the details of these instructional episodes and chronicling students' responses, this study may help guide other investigations in exploring more precisely the dynamics of responsive teaching.

References

Anderson, C. W., & Lee, O. (1997). Will students take advantage of opportunities for meaningful science learning? *Phi Delta Kappan, 78*(9), 720–724.

Arhar, J. M. (1997). The effects of interdisciplinary teaming on teachers and students. In J. L. Irvin (Ed.), *What current research says to the middle level practitioner* (pp. 49–55). Columbus, OH: National Middle School Association.

Bransford, J., Brown, A., & Cocking, R. (2000). *How people learn.* Washington, DC: National Academy Press.

Carolan, J., & Guinn, A. (2007). Differentiation: Lessons from master teachers. *Educational Leadership, 64*(5), 44–47.

Cross K. P. (1999, June). *Learning is about making connections.* League for Innovation in the Community College Educational Testing Service, 3. Department of Education.

Felner, R. D., Jackson, A., Kasak, D., Mulhall, P., Brand, S., & Flowers, N. (1997). The impact of school reform for the middle years: Longitudinal study of a network engaged in Turning Points-based comprehensive school transformation. *Phi Delta Kappan, 78*(7), 528–532, 541–550.

George, P. S., & Alexander, W. M. (1993). *The exemplary middle school* (2nd ed.). Orlando, FL: Harcourt Brace.

Hammond, C. (2007) *Dropout risk factors and exemplary programs: A technical report.* Clemson, SC: National Dropout Prevention Center, Clemson University and Communities in Schools.

Hammerness, K., Darling-Hammond, L., & Bransford, J. (2005). How teachers learn and develop. In L. Darling-Hammond & J. Bransford (Eds.), *Preparing teachers for a changing world* (pp. 358–389). San Francisco, CA: Jossey-Bass.

Jackson, A., & Davis, G. (2000). *Turning points 2000: Educating adolescents in the 21st century.* New York, NY: Teachers College Press.

Kuntz, S. (2005). *The story of Alpha: A multiage student-centered team—33 years and counting.* Westerville, OH: National Middle School Association.

Mertens, S. B., & Flowers, N. (2004). Research summary: Interdisciplinary teaming. Retrieved from http://www.nmsa.org/ResearchSummaries/Summary21/tabid/250/Default.aspx

Menzel, P., & Daluiso, F. (2007). *Hungry planet: What the world eats.* Napa, CA: Material World Books.

Reed, D, K., & Groth, C. (2009). Academic teams promote cross-curricular applications that improve learning outcomes. *Middle School Journal, 40*(3), 12–19.

Smith, T. W., & Colby, S. A. (2007). Teaching for deep understanding. *The Clearing House, 80*(5), 205–210.

Strahan, D., & Hedt, M. (2009). Teaching and teaming more responsively: Case studies in professional growth at the middle level. *RMLE Online—Research in Middle Level Education, 32*(8).

Tomlinson, C. A. (2003). *Fulfilling the promise of the differentiated classroom.* Alexandria, VA: Association for Supervision and Curriculum Development.

VanTassel-Baska, J., Feng, A. X., Brown, W., Bracken, B., Stambaugh, T., French, H., McGowan, B. W., Quek, C., & Bai, W. (2008). A study of differentiated instructional change over three years. *Gifted Child Quarterly, 52,* 297–312.

VanTassel-Baska, J., Avery, L., Struck, J., Feng, A., Drummond, D., & Stambaugh, T. (2003). *The William and Mary classroom observation scales–revised (COS-R).* Williamsburg, VA: Center for Gifted Education.

Virtue, D., Wilson, J., & Ingram, N. (2009). In overcoming obstacles to curriculum integration, L.E.S.S. can be more. *Middle School Journal, 40*(3), 4–11.

Yin, R. K. (2009). *Case study research: Design and methods* (4th ed.). Los Angeles, CA: Sage.

