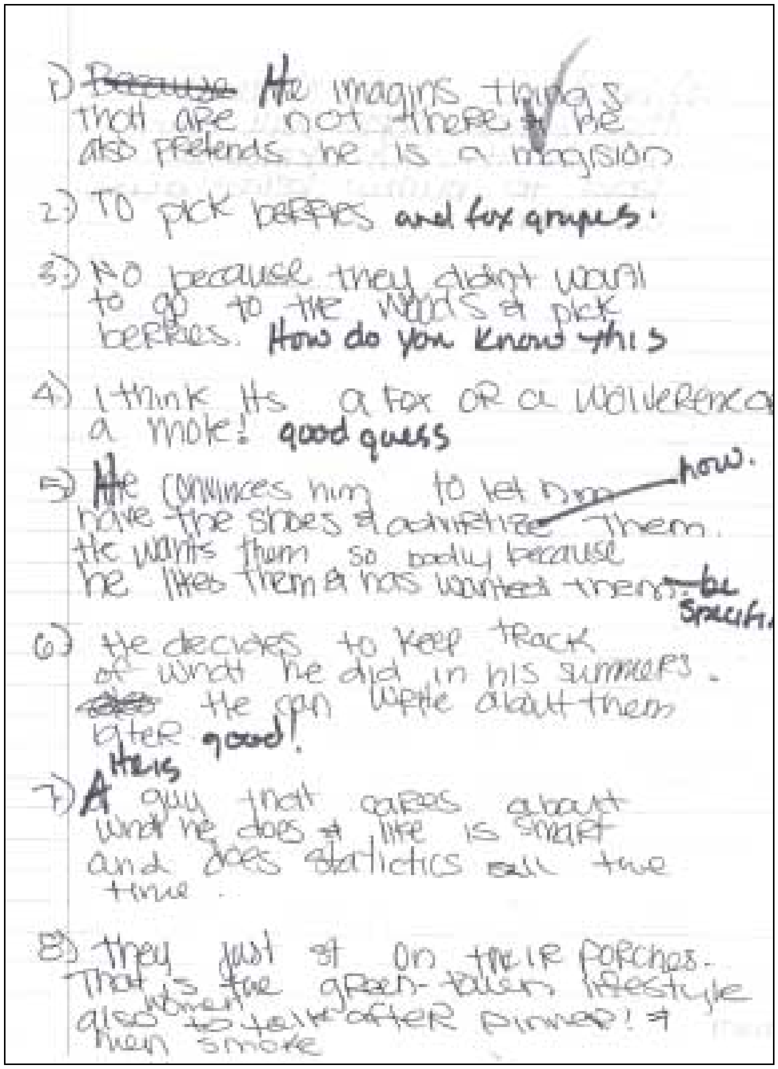
Exploring Assignments, Student Work, and Teacher Feedback in Reforming High Schools:
2002-03 Data from Washington State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A Report from the Evaluation of the Bill & Melinda Gates Foundation's National School District and Network Grants Program

January 2004

AMERICAN INSTITUTES FOR RESEARCH

SRI International

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Chapter 1: Rationale for Examining Assignments, Student Work, and Teacher Feedback

Leaders at the Bill and Melinda Gates Foundation have dedicated themselves and a substantial portion of their education portfolio to improving American high schools. In particular, they seek to reduce inequities in the educational experiences of historically underserved teens. Foundation officials want to help convert large, troubled high schools into small learning communities where all students excel. Additionally, they want to help create new small schools that replicate promising high school models. Reformers in foundation-supported schools are working to create learning environments that are personalized, authentic, and rigorous; that prompt students to take responsibility for learning, make choices, and do high-quality work; and that are linked to the broader community and real-world concerns (http://www.gatesfoundation.org/Gates/Grants).

Researchers at the American Institutes for Research (AIR) and SRI International are studying these efforts. We are working with foundation officials and reformers across the country to study high school change and what it takes to improve teaching and learning. We are examining the extent to which foundation-supported schools adopt elements of effective schooling and show better, more equitable outcomes for students. We also are investigating the factors that promote or impede school change and its sustained success.

We are collecting a wide range of quantitative and qualitative data in foundation-supported schools. We are observing classrooms, interviewing teachers and other school leaders, and talking to students about what they do. We also are interviewing school district leaders and staff in the organizations charged with helping schools reform. We are collecting quantitative data through surveys administered to principals, teachers, and students and we are collecting achievement test data. We are following foundation-supported schools over time and comparing their activities and outcomes to those of conventional high schools nearby.

In addition to this work, we are taking a careful look at teaching and learning. For a subset of schools in the larger evaluation, we are working with teachers to paint a detailed picture of instruction and of students' academic work. We are trying to determine whether students in foundation-supported schools are exposed to challenging learning opportunities and whether challenging learning opportunities open the door to intellectually complex student work. We are studying these questions by collecting samples of the assignments students tackle and the work that they produce. We are examining the rigor and authenticity of assignments and the quality of the resulting student work. We are coupling the data with information from jurisdiction-sponsored standardized tests and data from the broader evaluation.

We are collecting the assignments and student work from English/language arts and mathematics teachers in 24 foundation-supported schools over time.[1] We will use the data to show how teaching and learning evolve as reformers continue their work. We also will contrast these data to assignments and student work for conventional high schools in the same districts.[2]

Relationship to Prior Research on Authentic Intellectual Achievement

This study builds on research conducted in the Chicago Public Schools by Fred Newmann, Tony Bryk, and their colleagues (Newmann, Lopez, & Bryk, 1998; Bryk, Nagaoka, & Newmann, 2000; Newmann, Bryk, & Nagaoka, 2001). Their research in Chicago elementary and middle schools examined students' opportunities to construct knowledge, communicate clearly and well, do work with authentic purposes, and use language and mathematics conventions accurately and effectively. Their work suggests that assignments that demand higher-order thinking skills, deep understanding of content, elaborated communication, and activities that are similar to real-world tasks elicit work that is intellectually more complex from students.

Our research follows their methods and builds on their measurement model for assignments and student work by extending their scoring criteria to high school assignments and student work. In addition, we are studying two aspects of teaching and learning not examined by the Chicago research. We also are studying:

- The choices that students make about what they will study and how they will learn.
- The quality of teacher feedback on student work.

[1] See the Technical Appendix of this report for details on our school sampling plan.
[2] We will collect assignments and work from eight conventional high schools that offer useful comparisons for the foundation-supported schools.

Beginning our Work in Washington State

We began our nationwide study of teaching and learning in foundation-supported schools with a pilot study in Washington State. We will use this experience to test our methods and measures in high school settings and to strengthen the work before expanding our data collection.

This report describes our pilot work in 2002-03 with eight large Washington high schools planning to begin conversion to small learning communities in 2003-04. We will return to these schools in 2004-05 to see whether and how teaching and learning have changed.

In 2003-04 our work will move beyond Washington State across the country to other large high schools planning to convert to small schools and to several new small high schools. As with the schools in Washington, we will follow these schools over time to see how teaching and learning evolve. We also will contrast their work with the efforts of teachers and students in conventional high schools.

Purpose of This Report

This report describes our measures of the rigor and authenticity of assignments, the quality of student work, and the utility of teacher feedback. It details our data collection methods, gives examples of the assignments and work we gathered, describes their scoring, and discusses our results. It examines the quality of the measures and makes suggestions for improving them and our methods moving forward.

Chapter 2: Our Measures of Rigor, Authenticity, and Quality

We began our work in Washington State by enlisting the participation of English/language arts and mathematics teachers in eight large high schools scheduled to undergo conversion in 2003-04. In 2002-03, we asked 24 10th-grade English/language arts and 24 10th-grade mathematics teachers in the eight schools for copies of their assignments and student work. We asked teachers to provide us with eight of their assignments over the course of the school year and for the work of 12 randomly selected students in response to three of the eight assignments. We asked teachers for four assignments that were typical of their students' day-to-day activities and for four assignments that challenged students to show what they knew and could do at high levels. For each assignment, we also asked for descriptions of teaching objectives, teaching resources, and assessment goals.[3]

Sample Assignments and Work in English/Language Arts

Examples of the typical and challenging assignments we gathered and the work that resulted from them in English/language arts are shown in Figures 2.1 through 2.4. Figure 2.1 provides an example of an assignment described as typical of students' day-to-day activities by one of the participating teachers.

Figure 2.1: Typical Assignment in 10th-Grade English/Language Arts

Dandelion Wine

Using pages 1 through 32 in the novel *Dandelion Wine*, answer the following questions in complete sentences. Use a separate sheet of lined paper so you have plenty of room to write.

1. How does Doug use his imagination to turn an ordinary experience into a magical one?
2. Why does their father take Doug and Tom to the forest?
3. Does Doug seem to share his father's respect and love for nature? Give an example from the book to support what you decide.
4. What do you think the "thing" that Doug feels in the woods turns out to be?

[3] See the Technical Appendix of this report for details on the sampling and data collection procedures for Washington State.

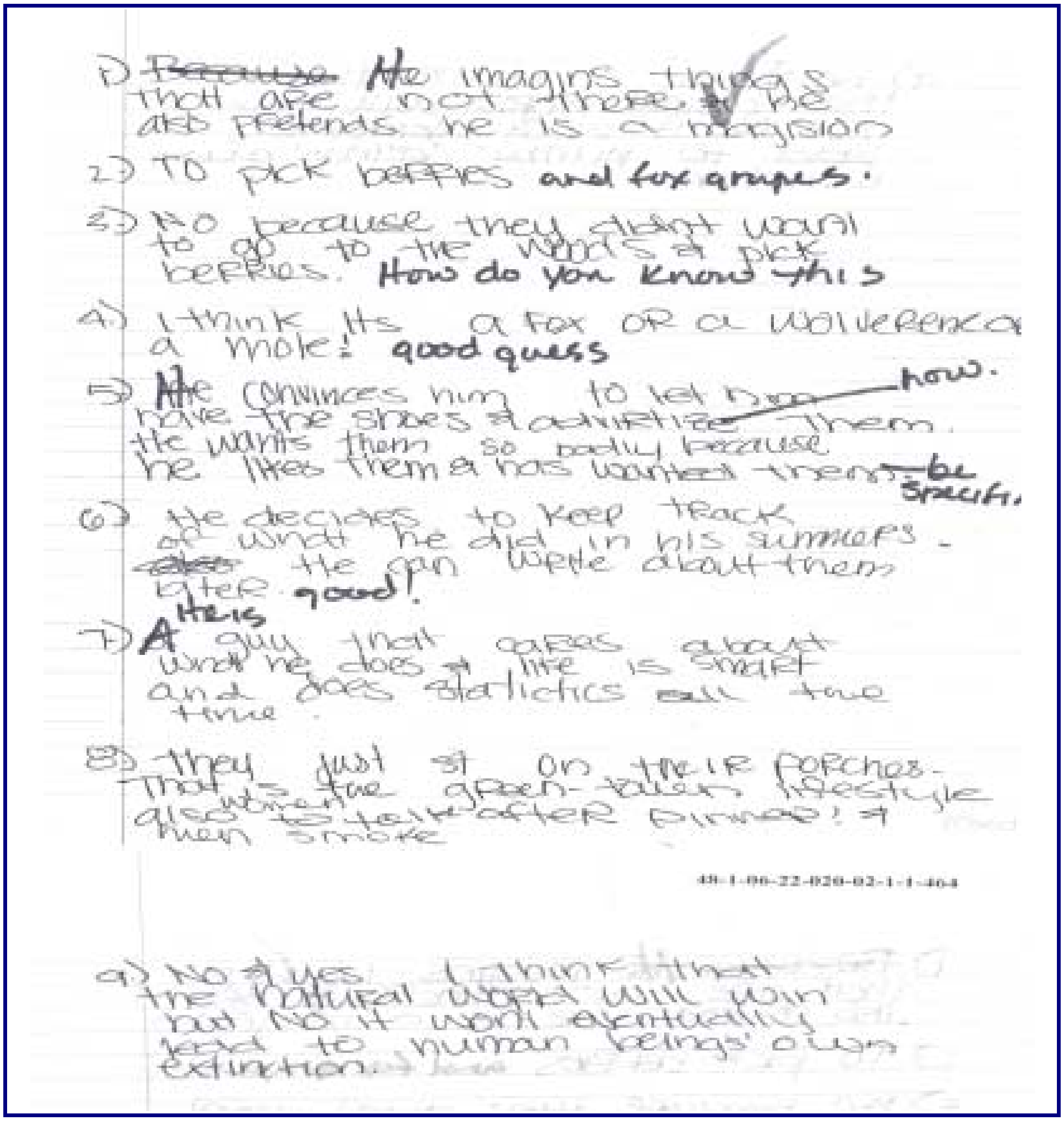
Figure 2.1: Typical Assignment in 10th-Grade English/Language Arts (concluded)

5. What does Doug convince Mr. Sanderson to let him have? Why does he want it so badly?
6. What does Doug decide to keep track of? What good will it be to him later as an author?
7. Describe Tom, Doug's younger brother.
8. How do the porches of summer cause Green Town lifestyles to change?
9. Do you agree that the natural world will win in the end—will human beings' gradual takeover of the wilderness eventually lead to human beings' own extinction?

A review of this assignment reveals that students can successfully complete most of its requirements by summarizing or paraphrasing information from the novel, *Dandelion Wine*. Little generation or exploration of new ideas is required to answer most of the questions. The assignment specifies the content of student work and the way that mastery should be demonstrated. Students do not need to write extensively in response, and the assignment has little application beyond the classroom.

Figure 2.2, shown next, provides an example of student work that responds to the *Dandelion Wine* assignment.

Figure 2.2: Student Work for a Typical Assignment in 10th-Grade English/Language Arts



1) ~~Because~~ He imagins things that are not there. & he also pretends he is a magision
2) To pick berries and fox grapes.
3) No because they didnt want to go to the woods & pick berries. How do you know this
4) I think its a fox or a wolverene or a mole! good guess
5) He convinces him to let him have the shoes & advirtize them. how. He wants them so badly because he likes them & has wanted them. be specific.
6) He decides to keep track of what he did in his summers. ~~also~~ He can write about them later good!
7) He is A guy that cares about what he does & life is smart and does statistics all the time
8) they just sit on their porches. That's the green-town lifestyle also women talk after dinner! & men smoke

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9) No & yes. I think that the natural world will win but no it won't eventually lead to human beings' own extinction.

The student whose work is shown in Figure 2.2 responded fairly successfully to the *Dandelion Wine* assignment. As just mentioned, however, the assignment called for very little original or elaborate communication. The student responded briefly, primarily by recounting information from the novel.[4]

[4] The teacher feedback on this and other student work samples is discussed later in the chapter.

In Figure 2.3 an example is shown of an assignment described as intellectually challenging for students by the teacher who provided it.

Figure 2.3: Challenging Assignment in 10th-Grade English/Language Arts

Psychiatrist Writing Assignment

You are to write a two- to three-page paper about Holden Caulfield from *Catcher in the Rye.* Write the paper as if you are Holden's psychiatrist. You are to choose three things about Holden's personality to discuss, then analyze those three things, and write what you think about them. Try and relate to Holden—identify what is wrong with his thinking.

This assignment calls on students to identify the character traits of interest to them; move beyond the literal meaning of the text to analysis and evaluation of Holden's personality; and support their arguments with detail, illustrations, or reasons. By specifying that three traits be examined, the assignment prompts extended writing.

Figure 2.4 provides an example of student work responding to the Psychiatrist Writing assignment.

Figure 2.4: Student Work for a Challenging Assignment in 10th-Grade English/Language Arts

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The Catcher in the Rye

"Good evening Holden! Im very glad that you could make this last meeting of ours, sense you do know Im leaving for retirement. I have been your psychiatrist for sometime now Holden and I think its time to discuss some important matters. I think I should start off by saying Holden that you are a very courageous boy for saying and doing things that you feel are right for you and not for anyone else. While others never say what they feel or never do anything for themselves. That takes guts. But I would also like to discuss some certain issues I've noticed about you. Just a few suggestions I have to help you in your situation and to help you understand where Im coming from. To make this easy for you and me I picked three words that I think best describe you, and with these three words Im going to define each one to help you better understand what exactly they mean. Okay? Lets give it a whirl.
First word...

In isolation: This is the very first word I picked because its the first vibe that I got from you. Holden I've noticed you always say a word called phony, and I see that you apply this to manly people. You always state how someone is phony, or their doing something phony, and their looking phony, and well basically just phony. But Holden, did it ever occur to you that maybe their trying to be nice? That just maybe their trying to get to know you more, maybe understand you a little better? It seems that your so bitter to allot of people. Maybe if you just tried to understand them you would understand where their coming from, and you wouldn't think their so what you call phony. But don't get me wrong. Im not saying that you are a very secluded person cause also from what I see there are certain people that you do care about. For example your brother Allie. It seems you cared a whole lot for him, and when he passed away you kind of died with him. It hurt you. You stated how intelligent he was and how he never got mad at anyone. You also care a whole lot about your sister Phoebe. You say how she brings in straight A's and is just great to talk to. But Holden these people are young. Could it be that maybe you still have a mind of a child? Maybe your not ready to be on your own and make decisions that regard your life. You might think you are ready to face the real world but if you keep isolating people its going to be very hard out there. Its going to seem that the only sane person in the world is you. So maybe after this meeting you could try not being so harsh and maybe not having a judgment right away.

1

Figure 2.4: Student Work for a Challenging Assignment in 10th-Grade English/Language Arts (continued)

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My second word...

Intimidated: Now I don't think your'e intimidated by allot of people but certain ones. For instance you told me that on your date with Sally you guys went to go see The Lunts, and on this date Sally saw someone she knew, and he came and talked to her. You stated that I should have seen the way he hugged her and the way they said Hello to each other. Now Holden, was it really as bad as it seemed or perhaps someone was a little jealous? I think you really liked Sally considering the fact of how good you told me she looked. But this isn't the only time I recall you getting jealous. I happen to remember the time you told me when your roommate at Pencey Prep named Stradlater had a date with a girl named Jane. It also seemed you really like this girl too. While he was gone you kept thinking about what they were doing and what was happening, and when Stradlater came back you were really eager to know what had happen. So eager that you and Stradlater got in a fight. I think this shows that this girl was very important to you. See Holden by being in isolation people will never know who you like. See if Stradlater would have known you liked her maybe the whole date wouldn't have never happened. But also maybe if you would have told Jane how you felt she would have never gone on the date either. My point Holden is that people can't read your mind. By letting people in even if they are phony they'll care. Being intimidated is actually a good thing. Its means you do have feelings and care about more people then just your brother Allie and sister Phoebe.

Finally, my third word...

Confident: Yes Holden hard to believe I picked this word after all the crap I have just given you. But its true and its you. You seem pretty sure of yourself even after getting kicked out of school and experiencing certain things. Like your first encounter with a prostitute. That doesn't happen in everyday life Holden. But that's not why I picked this word. You see when you got kicked out of Pency Prep you decided to go see your teacher Mr.Spencer and to listen to what he had to say. A teacher who even flunked you. You see to me that shows you have confidence in yourself even after everything that's happen to you. Not allot of people have that. Some would say Damn, what do I do now? Some might even cry. But you, you just delt with it, and that Holden is truly a gift.

So to wrap up our last meeting I would like to tell you I hope you take my words I have given you and use them wisely. My biggest fear in life are people, cause their liable of anything. But I know no matter what, I have to deal with them. Just like you Holden. Whether you like it or not, phony or intelligent you have to deal with them. All of them. Im sure you can see how my words I picked for you conjoin altogether. See Holden being in isolation is not helping very much in your life. Your always negative. Its okay to smile once in awhile. But its also okay to have a crappy day once in awhile too. Look

Figure 2.4: Student Work for a Challenging Assignment in 10th-Grade English/Language Arts (concluded)

48-1-03-22-049-03-2-3-584

Holden your young. Enjoy it while you can, cause other wise you'll grow up to be a sad and grumpy old man! So take care of yourself Holden. Oh and Holden you can see Mrs. Cadle on your way out if your interested in finding a new psychiatrist. It was a pleasure having you. Hopefully all goes well. Bye Holden."

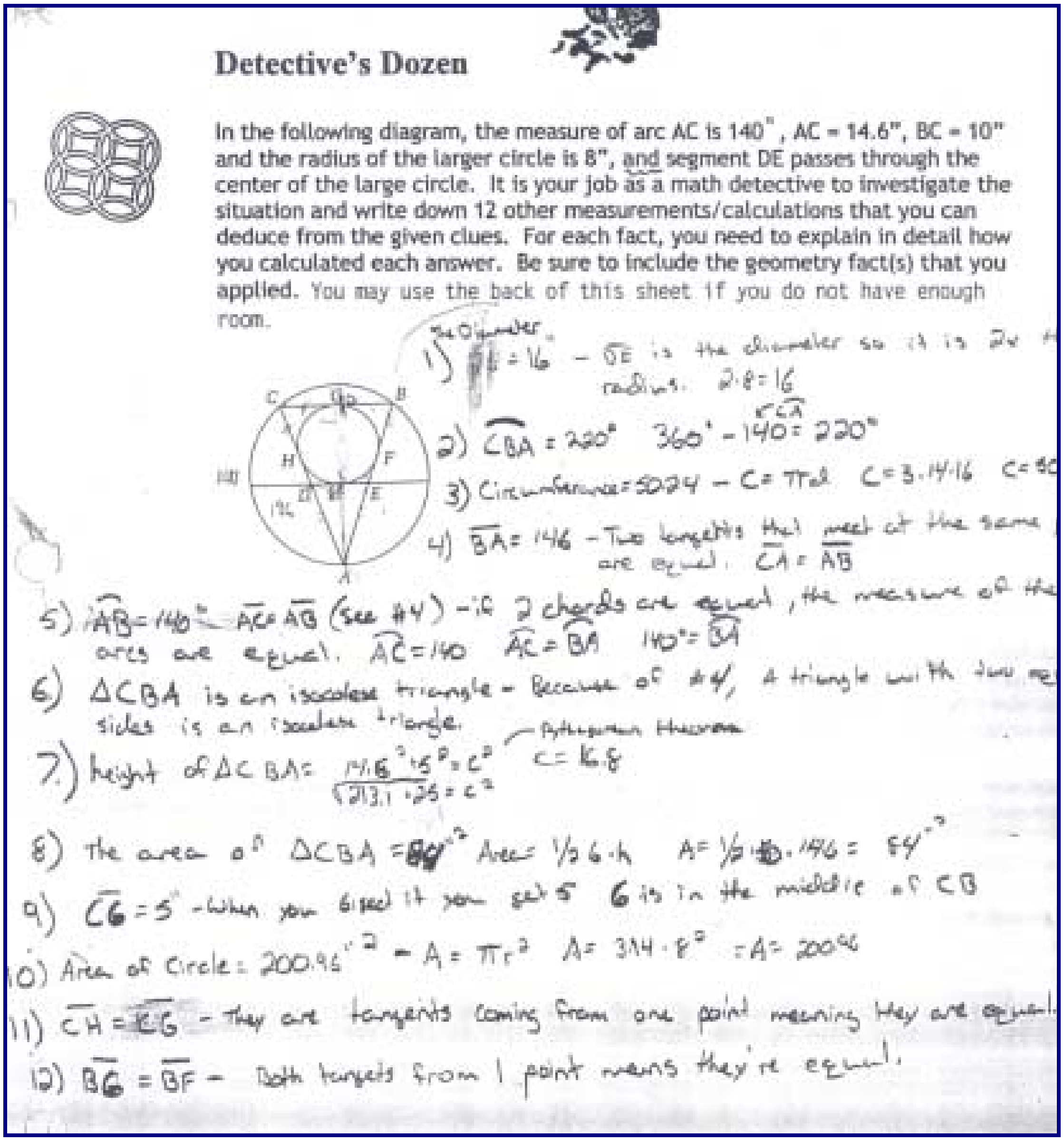
Nice - good, specific content used in analysis 30/30

The reader will note that this student's response went beyond the information in the novel to formulate and test theses about Holden's psyche. In this work, the student analyzed and evaluated relevant information and provided evidence for assertions. The writing is sufficiently developed, coherent, and well organized. Though there are some errors in spelling and usage, they present no problem for understanding the student's meaning.

Sample Assignments and Work in Mathematics

Examples of the typical and challenging assignments we gathered and the work that resulted from them in mathematics are shown in Figures 2.5 through 2.7. Figure 2.5 gives an examples of an assignment described as typical of students' day-to-day activity by the teacher who provided it.

Figure 2.5: Typical Assignment with Student Work in 10th-Grade Mathematics



Detective's Dozen

In the following diagram, the measure of arc AC is 140°, AC = 14.6", BC = 10" and the radius of the larger circle is 8", and segment DE passes through the center of the large circle. It is your job as a math detective to investigate the situation and write down 12 other measurements/calculations that you can deduce from the given clues. For each fact, you need to explain in detail how you calculated each answer. Be sure to include the geometry fact(s) that you applied. You may use the back of this sheet if you do not have enough room.

1) DE = 16 – DE is the diameter so it is 2× the radius. 2·8 = 16
2) CBA = 220° 360° – 140° = 220°
3) Circumference = 50.24 – C = πd C = 3.14·16 C = 50
4) BA = 14.6 – Two tangents that meet at the same point are equal. CA = AB
5) AB = 140° – AC = AB (see #4) – if 2 chords are equal, the measure of the arcs are equal. AC = 140 AC = BA 140° = BA
6) △CBA is an isosceles triangle – Because of #4, A triangle with two equal sides is an isosceles triangle.
7) height of △CBA: 14.6² + 5² = c² – Pythagorean theorem; √(213.1 + 25) = c² c = 16.8
8) The area of △CBA = 84" Area = ½ b·h A = ½ 10·14.6 = 84"
9) CG = 5" – When you bisect it you get 5 G is in the middle of CB
10) Area of Circle: 200.96"² – A = πr² A = 3.14·8² = A = 200.96
11) CH = CG – they are tangents coming from one point meaning they are equal.
12) BG = BF – Both tangents from 1 point means they're equal.

To complete this assignment correctly, students have to apply their knowledge of basic geometry facts (e.g., area of a triangle and circle, facts associated with chords and tangents of circles, etc.). Students also are required to demonstrate procedural knowledge and apply some problem-solving strategies to a fairly routine problem context. The assignment, however, does not provide an opportunity for students to demonstrate understanding of the underlying principles. Students are required to substantiate each measurement or calculation with a basic rule or fact of geometry.

The student work that is shown in Figure 2.5 demonstrates successful application of relevant geometry facts with only a few minor procedural errors. In general, the student supported each of her answers with a reasonably complete explanation by stating a basic rule of geometry. The work itself provides little opportunity to judge the student's conceptual understanding of underlying principles, nor does it provide any indication of the student's problem-solving and reasoning abilities.

Figures 2.6 and 2.7 provide examples of a challenging mathematics assignment and a sample of student work responding to it.

Figure 2.6: Challenging Assignment in 10th-Grade Mathematics

Just Count the Pegs

Freddie Short has a new shortcut. He has a formula to find the area of any polygon on the geoboard that has no pegs in the interior. His formula is like a rule for an In-Out table in which the *In* is the number of pegs on the boundary, and the *Out* is the area of the figure.

Sally Shorter says she has a shortcut for any geoboard polygon with exactly four pegs on the boundary. All you have to tell her is how many pegs it has in the interior, and she can use her formula to find the area immediately.

Frashy Shortest says she has the best formula yet. If you make *any* polygon on the geoboard and tell her both the number of pegs in the interior and the number of pegs on the boundary, her formula will give you the area in a flash!

Your goal in this POW (Problem of the Week) is to find Frashy's "superformula," but you might begin with her friends' more specialized formulas. Here are some suggestions about how to proceed.

1. Begin by trying to find Freddie's formula and some variations, as described in Questions 1a through 1d.

   a. Find a formula for the area of polygons with no pegs in the interior. Your formula should use the number of pegs on the boundary as the *In* and should give you the area as the *Out*. Make specific examples on the geoboard to get data for your table.

   b. Find a different formula that works for polygons with exactly one peg in the interior. Again, use the number of pegs on the boundary as the *In* and the area as the *Out*.

   c. Pick a number bigger than 1, and find a formula for the area of polygons with that number of pegs in the interior.

   d. Do more cases like Question 1c.

Figure 2.6: Challenging Assignment in 10th-Grade Mathematics (concluded)

2. Find Sally's formula and others like it, as described in Questions 2a through 2c.

   a. Find a formula for the area of polygons with exactly four pegs on the boundary. Your formula should use the number of pegs in the interior as the *In* and should give you the area as the *Out*.

   b. Pick a number other than 4, and find a formula for the area of polygons with that number of pegs on the boundary. Again, use the number of pegs in the interior as the *In* and the area as the *Out*.

   c. Do more cases like Question 2b.

When you have finished work on Questions 1 and 2, look for a superformula that works for all figures. Your formula should have two inputs—the number of pegs in the interior and the number of pegs on the boundary—and the output should be the area of the figure.

Try to be as flashy as Frashy!

3. Write–up

   1. Problem statement
   2. Process: Explain what methods you used to come up with your formulas.
   3. Solution: Give all the formulas you found.
   4. Evaluation
   5. Self-assessment

To complete this assignment successfully, students must demonstrate some conceptual understanding of area and be able to generalize from specific cases. There are two important mathematical ideas. In addition, the assignment requires students to engage in fairly substantial problem solving by asking them to generate models, test solutions, and reflect on their problem-solving strategies in writing. Students are asked to show their work and to support their solutions with written explanations. This assignment provides some guidance on the components students need to include for successful completion of the assignment.

Student work responding to the Just Count the Pegs assignment appears in Figure 2.7.

Figure 2.7: Student Work for a Challenging Assignment in 10th-Grade Mathematics

1. Problem Statement:

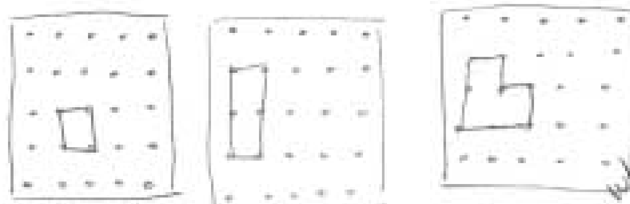
Freddie Short has a new shortcut to figure out the formula to find the area to a polygon on the geoboard that has no pegs on the inner part of it. The formula is like a rule for an in-out table. Which the *in* is the number of pegs on the boundary and the *out* is the area of the figure. Sally Shorter also has a shortcut but hers is for any polygon on the geoboard that has exactly four pegs on the boundary. All you need to do for her is tell her how many of the pegs are in the inner part of the polygon. She can use her formula to find the are of it quickly. Frashy Shortest says she has a better formula then both of them. If you have *any* kind of polygon all you need to do is tell her how many pegs are on the inner part of the polygon and the number of pegs in the boundary. Her formaula will also give you the answer quickly. The goal in the POW is to find Frashy's formula but first you need to start with her friends formulas.

good

2. Process:

1.a) The first thing that I did was I tried out each of the shortcuts. First shortcut I did was Freddie's. What I did was I made my own geoboard and put different shapes onto it. Then I made an in-out table. Looking at the different polygons that I had made I started to put them onto the in-out table. I put the number of pegs on the boundary on the *in* and the area of the figure in the *in*. I looked for a rule but I could not find one. My in-out table and my polygons looked like this:

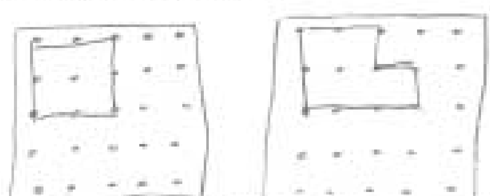
In	out
4	1
6	2
8	3



What is your rule?

B.) Next I made polygons with only one peg in the middle it. And I put those on the in-out table, like I did above. It looked like this:

In	out
8	4
10	5



The rule that I found for this was: The *in* divided by 2 equals the out. good

C.) I then picked a number and the number I picked was 4. I put it into the formula and so 4 would be the in and then divided by 2 equals 2 which is the out. So, 4 is the *in* and 2 is the *out*. Then I picked the number 5 and put it into the formula. Five divided by two equals two and a half. The *in* would be 5 and the

Figure 2.7: Student Work for a Challenging Assignment in 10th-Grade Mathematics (continued)

out would be 2 1/2.

2.a) What I did was try and find different polygons which had only 4 sides and had one peg in the middle. The only one that I found looked like this:

And my in-out table looks like this:

In	out
4	2

The formula that I came up with is the *in* divided by 2 equals the *out*.

B.) Another number (besides four) that I can pick to put into the formula would be 8. And so then putting 8 in the formula I would get 4. 8 divided by 2. The *in* therefore would be eight and the *out* would be 4. Then I picked the number 18 and put it into the formula. 18 divided by 2 equals 9. The *in* would be 18 and the *out* would be 9.

Frashy's "Superformula":

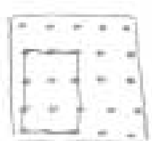
The formula that I found is: multiply the number of pegs in the middle of the polygon by the boundary. Then you have your solution. Take the solution and subtract that by the number the pegs in the middle of the polygon. Take that solution and divide it by the inner pegs. You then have another solution. You then take that solution and subtract it by three. An example: The *in* is 2 (number of pegs in the middle) and 10 (boundary) the *out* is 6. 10 x 2 = 20 - 2 = 18 / 2 = 9 - 3 = 6

this doesn't work for 4 and

The in-out table I had looked like this:

In		out
# of in pegs	Boundary	area
2	10	6
4	14	10

Shapes:



3. Solutions :

Freddie Short and Sally Shorter's formula was the *in* divided by 2 equals the *out*. And Frashy Shortest was the ?
multiply the number of pegs in the middle of the polygon by the boundary. Then you have your solution. Take the solution and subtract that by the number the pegs in the middle of the polygon. Take that solution and divide it by the inner pegs. You then have another solution. You then take that solution and subtract it

Figure 2.7: Student Work for a Challenging Assignment in 10th-Grade Mathematics (concluded)

by three.

4. Evalution:

I found this problem eduationally worth-well because I thought it was a good problem and it kept you thinking on how you can do it and I think that I learned from it! I don't think that you could change this problem to make in better I think it is good enough as it is. I think in a way that this problem was too hard because it took a really long time and you had to think really hard. It seemed like everytime you thought that you got it right then you figured something else out which made it wrong. I didn't like working on this problem because it took too long.

5. Self-assessment:

I think that I should get at least an A- because I think that I did very well on this and even though some of the things may not be correct. I tried very hard to do it.

The student work shown in Figure 2.7 demonstrates an understanding of the concept of area with some minor misconceptions. The student was fairly successful at extracting general rules from the patterns that emerged from geoboard figures and the data in the In-Out tables. The work demonstrates an appropriate use of problem-solving strategies but is not entirely successful. For example, although the work indicates a clear solution path, the path does not lead to the desired “superformula.” The work also contains some major procedural errors. Finally, the work communicates a reasonably complete explanation of the problem statement, process, and solution; however, the explanation is somewhat unclear with regard to finding the “superformula.”

Examining the Assignments, Student Work, and Feedback

At the end of the school year, we hired and trained experienced high school English/language arts and mathematics teachers to examine the assignments and student work that we gathered and to rate them by using scoring rubrics that expanded on the Chicago Authentic Intellectual Achievement scoring rubrics. Our rubrics examined students’ opportunities to construct knowledge, communicate clearly and well, do work with authentic purposes, participate in decision making about learning activities, use language and mathematics conventions accurately and effectively, and refine and improve their work.

English/Language Arts Assignments

More specifically, in English/language arts, the scoring rubrics for assignments examined the following four criteria:

- *Construction of Knowledge*. Scorers examined the extent to which assignments called for student work that moved beyond the mere reproduction of information to the construction of knowledge. Assignments that emphasized construction of knowledge required students to do more than summarize or paraphrase information they had read, heard, or viewed; these assignments required students to create or explore ideas that were new to them.
- *Elaborated Communication.* Assignments that emphasized elaborated communication required extended writing and asked students to make assertions and support them with evidence.
- *Authentic Audiences.* Assignments that had authentic audiences fulfilled purposes other than merely earning course credit and had audiences other than the teacher as grader. These assignments asked students to consider the concerns of and present their work to authentic audiences.
- *Student Involvement in Crafting Assignments.* Scorers looked for evidence that students were invited to make choices about what they would study and how they would learn. Scorers also looked for teachers' guidance on how students could meet instructional goals.

English/Language Arts Student Work

The scoring rubrics for student work in English/language arts followed some of the same criteria used for assignments; they examined three features of English/language arts work:

- *Construction of Knowledge.* Scorers examined student work for the degree to which it moved beyond the reproduction of information to the construction of knowledge. Work that demonstrated construction of knowledge did more than summarize or paraphrase information students had read, heard, or viewed; it showed that students created or explored ideas that were new to them.
- *Elaborated Communication.* Scorers also examined the extent to which students demonstrated elaborated communication through extended writing that made an assertion and then supported it with evidence. This rubric also examined the extent to which student writing was sufficiently developed, coherent, and well organized.
- *Effective Use of Language Conventions and Resources.* The final student work rubric examined the extent to which students

demonstrated proficient use of language conventions and language resources. This rubric looked for spelling, vocabulary, grammar, and punctuation that were appropriate for 10th-grade work; it also looked for artistic use of language resources, including diction, syntax, imagery, and figurative language.

Mathematics Assignments

In mathematics, the scoring rubrics for assignments examined five sets of criteria:

- *Important Mathematics Content*. Scorers examined the extent to which assignments called for student work demonstrating deep conceptual understanding in one or more of the important ideas in mathematics. These important ideas refer to the large and unifying ideas that help link smaller pieces of mathematics knowledge, that undergird procedural skills, and that connect mathematics within and between content domains. Assignments should provide a key purpose for learning mathematics and should serve as organizing ideas for instruction. Among the important ideas that 10th-grade assignments address are chance, dimension, change and growth, transformation, interrelationships, translation of problems from one language to another, proportionality, and function and recursion. In addition, critical mathematical processes that support the development of these important ideas, such as proof, making and justifying conjectures, and using models and varied representations, are considered essential ideas.
- *Problem Solving and Reasoning*. Assignments that required problem solving or reasoning asked students to formulate problems from situations, make generalizations, judge the validity of arguments, make models, and construct valid arguments and proofs. These go beyond assignments that require students to retrieve or reproduce fragments of knowledge or simply apply previously learned algorithms or procedures.
- *Effective Communication about Mathematics*. Scorers examined the extent to which assignments explicitly called for communication of mathematical understanding. Assignments that called for communication asked students not only to “show their work” (i.e., provide a trace of the solution path) but also to “explain or justify,” providing insight into the clarity of the students’ mathematical understanding.
- *Relevant Context and Real-World Connections*. Scorers looked for evidence of the extent to which assignments asked students to address mathematical questions, issues, or problems similar to ones

encountered in the experience of mathematicians and other professionals who use mathematics to solve problems. In addition, this rubric examined the extent to which assignments specified an "authentic audience" for student work products.

- *Student Involvement in Crafting the Assignments*. Scorers examined the extent to which assignments allowed students to decide which topics they would investigate and which problems they would tackle. This rubric also examined the extent to which assignments gave students guidance in making choices about topics and problems that met their instructional goals.

Mathematics Student Work

The scoring rubrics for student work in mathematics examined four characteristics:

- *Conceptual Understanding*. Scorers examined student work for the degree to which it demonstrated conceptual understanding related to one or more important ideas in mathematics. Students demonstrated conceptual understanding when they provided evidence that they could represent and classify mathematical entities; recognize, label, and generate examples and non-examples of concepts; use and interrelate models, diagrams, manipulatives, and varied representations; and identify and apply mathematical principles.
- *Procedural Knowledge.* Scorers also examined the extent to which students demonstrated procedural knowledge of mathematical content, including knowledge of the key skills and processes in 10th-grade mathematics. Students demonstrated procedural knowledge by selecting and correctly applying appropriate procedures, verifying or justifying the correctness of a procedure using concrete models or symbolic methods, or extending or modifying procedures to deal with specific factors in problems.
- *Problem Solving and Reasoning.* This student work rubric examined the extent to which students demonstrated skill and understanding in problem solving and reasoning. Student work that demonstrated problem solving included problem descriptions, determinations of desired outcomes, generation of appropriate models, selection of possible solutions, solution strategy alternatives, testing of trial solutions, evaluation of outcomes, and any needed revisions of solution steps and strategies. Student work that demonstrated mathematical reasoning involved evidence of logical, systematic thinking. This included intuitive, deductive, or inductive reasoning in making and justifying conjectures and

solving problems. Reasoning often involved hypothesizing, predicting, analyzing, generalizing, synthesizing, or proving.

- *Effective Communication*. Scorers also examined the extent to which students demonstrated organized and consolidated mathematical thinking through written and oral communication; they looked for coherent and clear communication of mathematical thinking to peers, teachers, and others and for the correct use of mathematical notation and terminology.

Teacher Feedback

Additionally and importantly, for both English/language arts and mathematics student work, scorers looked for evidence of the provision of teacher feedback that would support student learning and better their work in the future. Starting with the thesis that teacher feedback can help students learn and improve their work (Bransford, Brown, & Cocking, 1999), scorers examined the amount and nature of teacher feedback on the student work samples:

- *Informative Feedback.* Scorers examined student work for the extent to which written feedback was provided, suggestions were made for the kinds of things students could do to strengthen the work, and guidance was provided on the application of the feedback to future work.

Examples of teachers' feedback are shown in Figures 2.2, 2.4, and 2.7 in this chapter and in Figures 3.3, 3.4, 3.11, and 3.12 in the next chapter. The reader will note that for some of these artifacts, teacher feedback merely remedies mechanical errors and content or comments on the quality of the work but does not say how to improve it. In other cases, teacher feedback provides information or a concept the student can use to refine the current work. None provide guidance for producing better work in the future.

Conducting the Scoring

As noted above, we hired 12 experienced teachers in English/language arts and 12 experienced teachers in mathematics to participate in scorer training and then score assignments and student work in their subjects during the summer. The scoring sessions were led by experts in the Authentic Intellectual Achievement framework and in the tenets of the Bill & Melinda Gates Foundation high school reform initiative. In each subject, teachers worked for a week to master the scoring rubrics and apply them to the Washington State assignments and student work.

To control for potential scorer bias, assignments and work were randomly assigned to scorers for each rubric.[5] Each English/language arts assignment was scored on the four assignment rubrics just described; student products were scored on three student work rubrics and one teacher feedback rubric. Mathematics assignments were scored on five assignment rubrics; student products in mathematics were scored on four work rubrics and one feedback rubric.

As a check on the reliability of scoring, all English/language arts and mathematics assignments were randomly assigned to a second teacher for a second scoring. Half of the student products in English/language arts were double-scored, and 40% of the mathematics student work was double-scored.

The dataset that was generated by the scorers in summer 2003 and the analyses they supported are discussed in the next chapter.

[5] See the Technical Appendix of this report for details on our paper assignment and scoring procedures.

Chapter 3: The Quality of Our Measures

In this chapter, we examine the procedures used to score assignments, student work, and teacher feedback. We begin with an examination of the reasonableness of the scoring data. We investigate whether the scores assigned to assignments and student work are likely to reflect important differences in the rigor and quality of the assignments, in the quality of students' efforts, and in the utility of feedback. This chapter takes a first step toward answering questions about the characteristics of the scoring data and the likely value of the information they provide.

We can think about the characteristics of our data in two ways. First, we can think about whether the different sets of scoring data relate to each other in sensible ways. Second, we can compare the scoring data with other things we know about teaching and learning in participating schools to see if the relationships make sense. In this project, we will do both. In this report, we will look at the different sets of scoring data to see if they make sense. Our next report, due in April 2004, will delve deeper into the relationships among different scoring data and it will relate the data to other information on teaching and learning in the Washington schools.

Scoring Assignments and Student Work

Scorers at our 2003 scoring session examined 177 English/language arts assignments and 399 student responses. In mathematics, scorers rated 184 assignments and 425 pieces of student work. As we mentioned in the previous chapter, there were 8 different English/language arts scoring rubrics and 10 mathematics rubrics. Some of the scoring rubrics had 3-point scales, others had 4 or 5 points, and one had a 6-point scale.[6] Again, all the assignments in English/language arts and mathematics were double-scored, and half of the student work products in English/language arts and 40% in mathematics were scored twice. We gathered these second scores in order to make judgments about the consistency of the ratings.[7]

Reliability of Scoring

We examined the assignments and work that were double-scored and counted the number for which scorer pairs were in perfect agreement, the number for which raters' scores differed by one point, and the number for which scores differed by more than one point. For the English/language

[6] See the Technical Appendix of this report for details on the rubric scales.
[7] See the Technical Appendix of this report for details on scoring and scoring reliability.

arts rubrics, scorer pairs were in perfect agreement on their ratings on between 60% and 69% of the papers on the eight different English/language arts rubrics.[8] The scores they assigned were the same or differed by no more than one point for between 79% and 96% of the papers on the different English/language arts rubrics. We consider these agreement rates to be acceptable; they are typical of agreement rates for performance assessment scorings with rubrics similar to ours, and they are similar to agreement rates calculated by the Chicago researchers.

Agreement rates on the 10 mathematics rubrics were slightly lower. Perfect agreement rates ranged from 44% to 92% of the papers on the different mathematics rubrics. Agreement rates on the different mathematics rubrics increased to between 79% and 100% of the papers when assignments and work with scores differing by one point were added to the calculation.

Although we consider these agreement rates acceptable, we plan to continue examining our scoring rubrics, training materials, and scoring procedures to see if we can strengthen our efforts and improve agreement rates as the study continues.

Scoring Data in English/Language Arts

After examining the reliability of our scoring data, we used a test analysis model called the Many-Facet Rasch Model to combine data across the different scoring rubrics and teacher scorers so that we could use a single score to characterize the rigor and authenticity of each English/language arts assignment. This combined score ranged from 0 to 10. We did the same for each piece of student work in English/language arts—that is, we created a single score to represent the quality of each student product. Like the assignment scores, the combined student work scores ranged from 0 to 10.[9] We followed these same procedures for mathematics assignments and student work.[10]

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[8] See the Technical Appendix of this report for the agreement rates on individual rubrics and for other data on the reliability of the scoring.
[9] See the Technical Appendix of this report for detail on the Many-Facet Rasch Model and for the results of the modeling process.
[10] Because the Rasch analyses used to produce single scores for assignments and student work products in each of the subject areas were conducted independently (and because the scoring rubrics differ across subject areas and for assignments and student work products), the resulting scales are not comparable. Thus, similar scores on the 0-10 scales hold different meanings, so a score of 3 on one scale does not necessarily hold the same meaning as a score of 3 on another scale.

Because there was only one feedback rubric in English/language arts and one in mathematics, it was not necessary to create a combined scale for the teacher feedback scores. Feedback scores are reported here on the same 1 to 4 scale on which they were originally assigned.

There are three ways we can make judgments about the reasonableness of the combined scores for assignments and student work. We will talk about all three of them next and provide data to help the reader examine our judgments about the data.

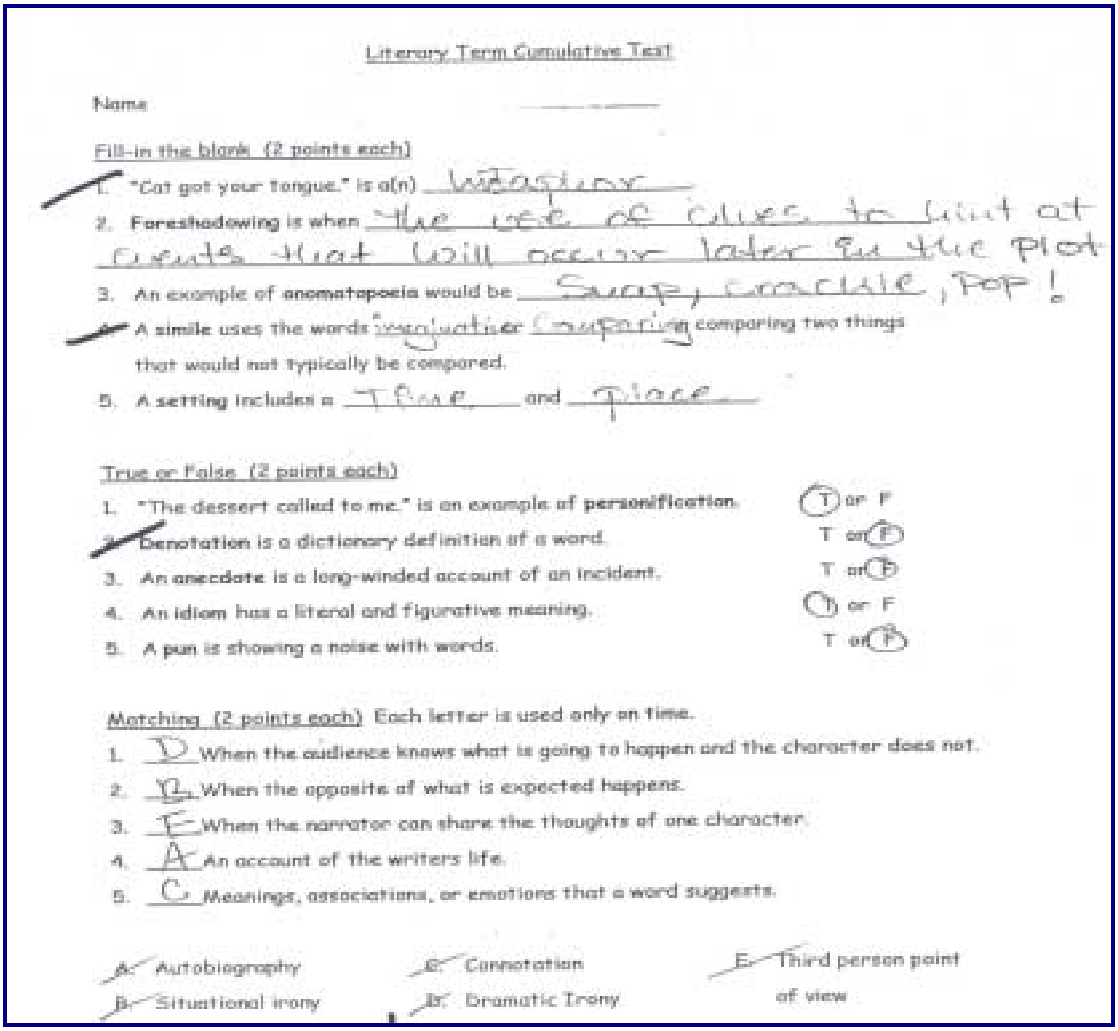
- The first way to determine if the combined scores make sense is to examine assignments and work that got low scores in the summer scoring and those that got high scores to see if these characterizations are believable.
- The second way to think about the reasonableness of the data is to examine the distributions of assignment and student work scores to see if the distributions have the expected properties—that is, that scores are approximately normally distributed without unusual dips or spikes in the displays.
- The third way to judge the reasonableness of the data is to compare the scores for assignments that teachers described as typical of students' day-to-day activities with those for assignments described as challenging for students. In general, we would expect the typical assignments and the student work that went with them to get lower scores than the challenging assignments and resulting work.

In this section of the report, we examine the English/language arts results using all three approaches. We look at sample assignments and student work, examine score distributions, and compare score data for assignments described as typical and challenging and at scores for the associated work.

Examples of Low- and High-Scoring Assignments and Student Work in English/Language Arts

Figure 3.1 provides an example of a low-scoring English/language arts assignment along with a low-scoring student response.

Figure 3.1: Low-Scoring Assignment and Low-Scoring Student Work in English/Language Arts



Literary Term Cumulative Test

Name ____________

Fill-in the blank (2 points each)

1. "Cat got your tongue." is a(n) Metaphor
2. **Foreshadowing** is when the use of clues to hint at events that will occur later in the plot
3. An example of **anomatopoeia** would be Snap, crackle, pop!
4. A **simile** uses the words imaginative or comparing comparing two things that would not typically be compared.
5. A **setting** includes a Time and place

True or False (2 points each)

1. "The dessert called to me." is an example of **personification**. T or F
2. **Denotation** is a dictionary definition of a word. T or F
3. An **anecdote** is a long-winded account of an incident. T or F
4. An **idiom** has a literal and figurative meaning. T or F
5. A **pun** is showing a noise with words. T or F

Matching (2 points each) Each letter is used only on time.

1. D When the audience knows what is going to happen and the character does not.
2. B When the opposite of what is expected happens.
3. E When the narrator can share the thoughts of one character.
4. A An account of the writers life.
5. C Meanings, associations, or emotions that a word suggests.

A. Autobiography
B. Situational irony
C. Connotation
D. Dramatic Irony
E. Third person point of view

The reader will note that to complete this assignment students are not expected to go beyond reproduction of knowledge; students need only demonstrate understanding of literary terms. The assignment does not require extended writing and the work that results is unlikely to have an audience beyond the teacher as grader.

The student work that is shown in Figure 3.1 is fairly successful but, again, the assignment does not call for an original or elaborated response or for demonstration of complex understanding. Modest scores seem appropriate for this assignment and student work sample.

Figure 3.2 provides an example of an assignment that received high ratings from our scorers.

Figure 3.2: High-Scoring Assignment in English/Language Arts

Reflective Essay

After reading the book *Night*, by Elie Wiesel, study the reflective essays included in your packets. Prepare to discuss the characteristics of reflective essays, including the use of dialogue, description, inner monologue, and conclusions that make “significant” statements and resolve “internal conflicts”. Afterward, draft your own reflective essay. Remember to pre-write, draft, and review. I will give you feedback on your draft and a grading rubric for the final essay.

This assignment calls for extended writing and demonstration of the tone, style, and conventions of reflective essays. To complete this assignment well, students need to move beyond reproduction of knowledge and explore new ideas. Students are asked to choose a reflection topic and demonstrate their analysis and interpretation skills. Students are encouraged to refine their work as they complete the assignment’s successive parts and on the basis of teacher feedback. A high score seems sensible for this assignment.

Figure 3.3 provides an example of a high-scoring student response to this assignment.

Figure 3.3: High-Scoring Student Work in English/Language Arts

"I love you [redacted] I'll pick you up around nine o'clock," My mom said as she leaned in for a kiss. As I pulled away I replied, "Yeah, bye mom!" That was the last conversation I thought I had ever had with my mom.

It was a "Wednesday Late Start" morning before school. My mom said goodbye before leaving for work around 7:45. She was annoying me that morning. For no reason at all I was frustrated by my mom. What had she done? She had done nothing wrong, and still I didn't feel a bit of guilt for talking to her that way. Why should I feel bad? I'll see her at nine o'clock anyway, I thought as I finished getting ready.

Nine o'clock rolled around and there was no sign of my mom. I didn't think anything of it. I'll give her a few extra minutes. Quickly, the clock read 9:10 and my mom was still not home. I decided to give her a call at work. "Hey, you've reached the voice mail of " said the machine. 'Well, maybe she's on her way', I thought as I dialed her cell phone number. "Hey you've reached the cell phone..." Where was she?

It was 9:15 and I could picture the sound of the high-pitched first bell ringing in my head. I tried both phones again. There was no answer. Soon, I could picture the sound of the second bell. I tried both phones again. There was still no answer. By 9:30 I knew something had to be wrong, So I decided to walk the whole 3 blocks to school.

As I walked, I started having troubling thoughts, Thoughts of my mom being in a bad car accident. I imagined her lying on a stretcher unconscious. I tried telling myself that I was too paranoid. As I was having all these thoughts, I had just rounded the corner onto Street. The moment I looked up my heart stopped. My whole body went into a cold sweat and I got chills down my back. All around, in front of the high school, were police cars, fire trucks, and the dreaded ambulance. I felt like crying. I felt like going home and turning the clocks back to 7:15 when my mom had leaned in to kiss me. I thought of our conversation we last had. How could I have treated her so rudely for no reason? I felt so bad inside. I just wanted to lie down and go to sleep. Maybe if I woke up again it would all be just a bad dream.

Figure 3.3: High-Scoring Student Work in English/Language Arts (concluded)

I walked slowly now thinking of the relationship my mom and I shared. I was headed straight for all the commotion. Then I saw my dad. He was standing on the sidewalk in the middle of all the chaos. I watched him as he starred at the ground. His expression was one I will never forget. 'This is real,' I thought. The reason my mom had not picked me up at nine o'clock had just been confirmed.

"Can you believe it?" My dad said with a smirk as he nudged my arm. I looked up at him and started to cry. "What is the matter, What happened?" He asked me. "What kind of question is that dad? What's going on?" I replied with frustration. He knelt down by my side and explained to me that a student set one of the school bathrooms on fire. That was what caused all the excitement. "That's it?" I yelled. That was the best news I had ever heard in my life! After saying goodbye to my dad, I walked into the school and headed for my mom's office to tell her how much I loved her.

What makes us so frustrated when all there is, is love? Why do people have built up anger in them for no reason? I will never know the answer to these questions but I do know that I want to change this within myself. I realized that I should live each day expressing my true feelings. From that day on, I decided to never complete a day without sharing at least five great feelings I was having. I made the decision to see the best in people and love each moment I have. As for my mom, I always wonder about her when we aren't together. But there's a peace in my wonderment. I never have to worry about regretting what I last said to her, because I know the last words were the greatest words of all... I love you!

The student work in Figure 3.3 includes extended writing that makes a point and then supports it with evidence. The essay is rich with detail and illustration. The writing demonstrates good analysis skills and competent command of language conventions and resources. Again, an upper-level score for this writing sample seems appropriate.

We end our discussion of the plausibility of the English/language arts scores with an example of teacher feedback. The student work in Figure 3.4 responds to an assignment on social and political issues. The assignment introduces several issues and then points students to relevant written and video materials on the issues. The assignment asks students to choose from among a set of topic statements and begin writing. The student work in Figure 3.4 includes teacher feedback.

Figure 3.4: Teacher Feedback in English/Language Arts

The United Stats is on the verge of war with Iraq. By having more sophisticated technology, stiffer policies, and more military will not help stop war with Iraq. use the Iraqis throughout paper

Sophisticated technology will not help stop war with Iraq. By the United States having so much power will only make us think that we are better than other countries. It will bring more problems to our country. How? No other country will be satisfied with ~~of~~ us having so much powerful technology.

Stiffer policies will only help small crimes, not the terroist. why? The terroist will not care ~~of~~ what policies we have if they want to attack, they'll attack us.

Having more military will only put more people in danger. Innocent people will die. The people that don't get killed and go to war will always have bad memories of war. Draft? 18-26 yr. olds 2/3 10% in war

My conclusion is that we

49-1-02-22-011-03-2-3-619

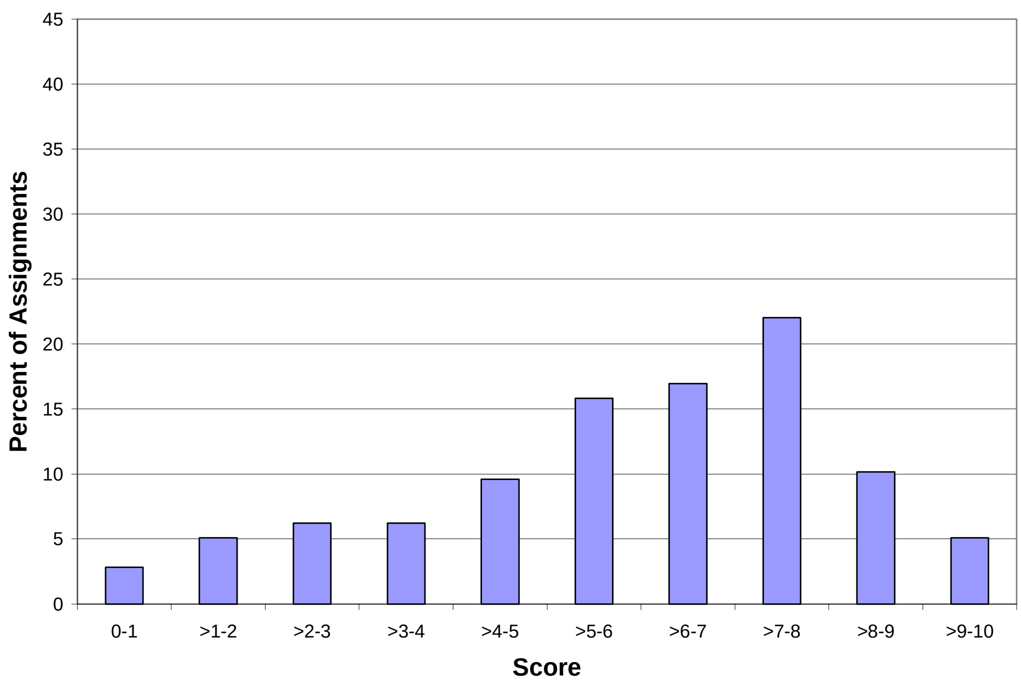
shouldn't have war with Iraq. If we do have war a lot of people will die and innocent families will be left behind.

This feedback provides information the student can use to revise or improve his or her essay. The feedback is specific to this work, though, and does not provide guidance on the application of the feedback to future work. This submission got a score of 3 on the 4-point teacher feedback rubric in English/language arts.

Score Distributions for Assignments and Student Work in English/Language Arts

Next, we examine the distributions of scores for assignments and student work, looking for any irregularities that signal potential problems with the rubrics and their implementation. Figures 3.5 through 3.7 display score distributions for assignment, student work, and feedback data in English/language arts. Figure 3.5 displays scores for English/language arts assignments.

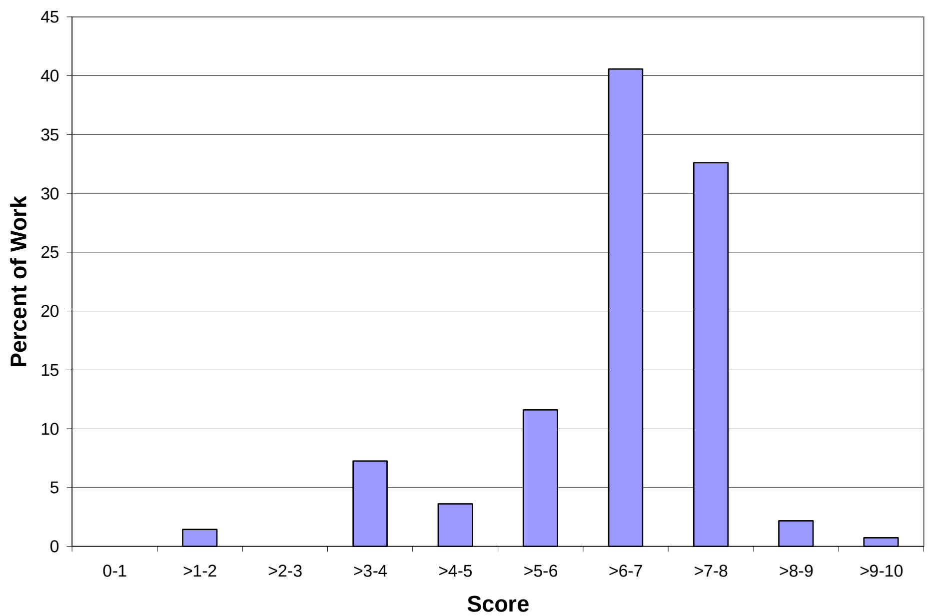
Figure 3.5: Score Distribution for Assignments in English/Language Arts



The reader will note that the English/language arts assignment scores are fairly evenly distributed across all of the score intervals. However, there are more scores in the top half of the distribution than in the bottom half. Because we hope to use these scales to chronicle change in teaching over time and because top scores better represent the foundation's instructional intentions, it would be preferable to have scores cluster initially in the bottom half of the distribution. Documenting positive change would be easier with more room at the top of the score scale. As we move forward in our work, we will look for opportunities to draw finer distinctions among assignments scoring in the top half of the English/language arts assignment distribution.[11]

Figure 3.6 shows the distribution of scores for student work in English/language arts.

Figure 3.6: Score Distribution for Student Work in English/Language Arts

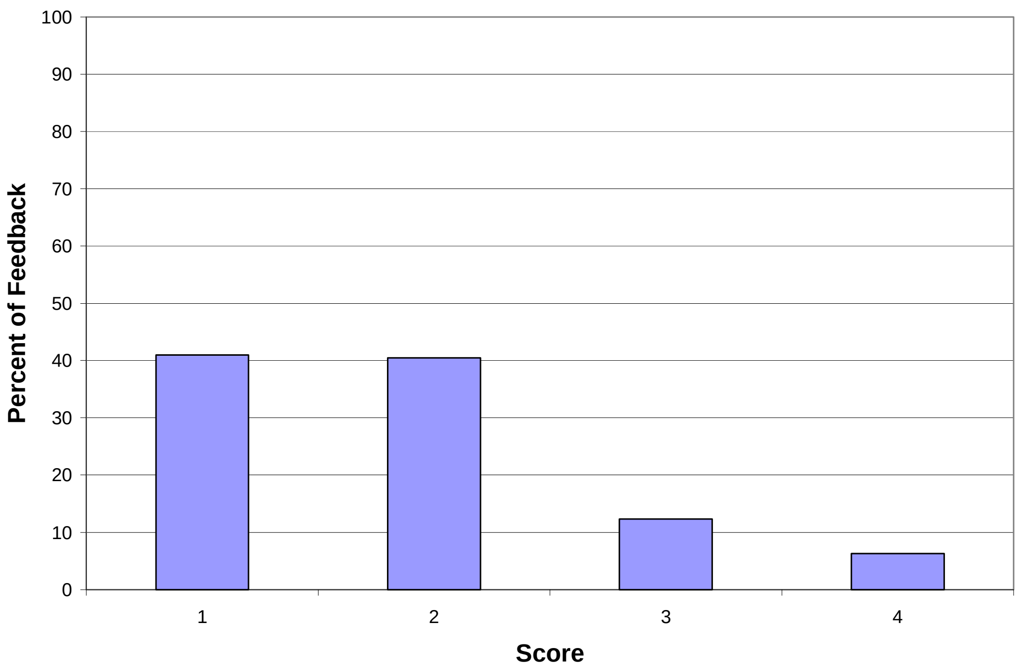


Here again, we see a clustering of scores above the midpoint of the distribution and would prefer to see more scores in the bottom half of the distribution. As we prepare for next summer, we will examine the score points with very little student work data and look for opportunities to draw finer distinctions between student work that is now clustered between scores of 6 and 8.

Figure 3.7 shows the distribution of scores for teacher feedback in English/language arts. Again, these data are reported on the scoring rubric scale, with the bottom score assigned to papers with no written feedback and the top score given to papers with feedback that informed improvements to the student's current work and that provided guidance for strengthening future products.

[11] The pros and cons of making refinements to the rubrics or scoring procedures are detailed in Chapter 5.

Figure 3.7: Score Distribution for Teacher Feedback in English/Language Arts

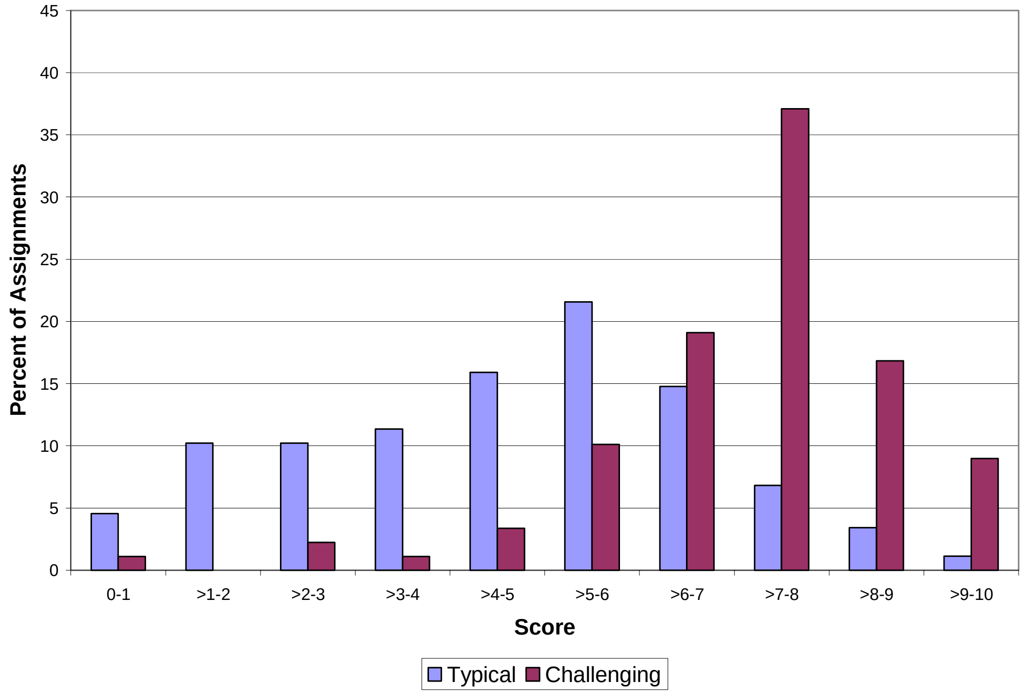


This display shows that approximately 40% of English/language arts papers received a score of 1; these papers included no written feedback. Less than 10% of the work received a score of 4; these papers included feedback about possible improvements to the current and future work. These data on the English/language arts feedback rubric indicate that there is ample room for improvement of teacher practice.

<u>Scores for Typical and Challenging Assignments and the Resulting Student Work in English/Language Arts</u>

Figure 3.8 takes the English/language arts assignment data shown above and displays the scores separately for typical and challenging assignments. In Figure 3.8 typical assignment scores are shown on the left of each pair of bars, while scores for challenging assignments appear on the right in each pair of bars.

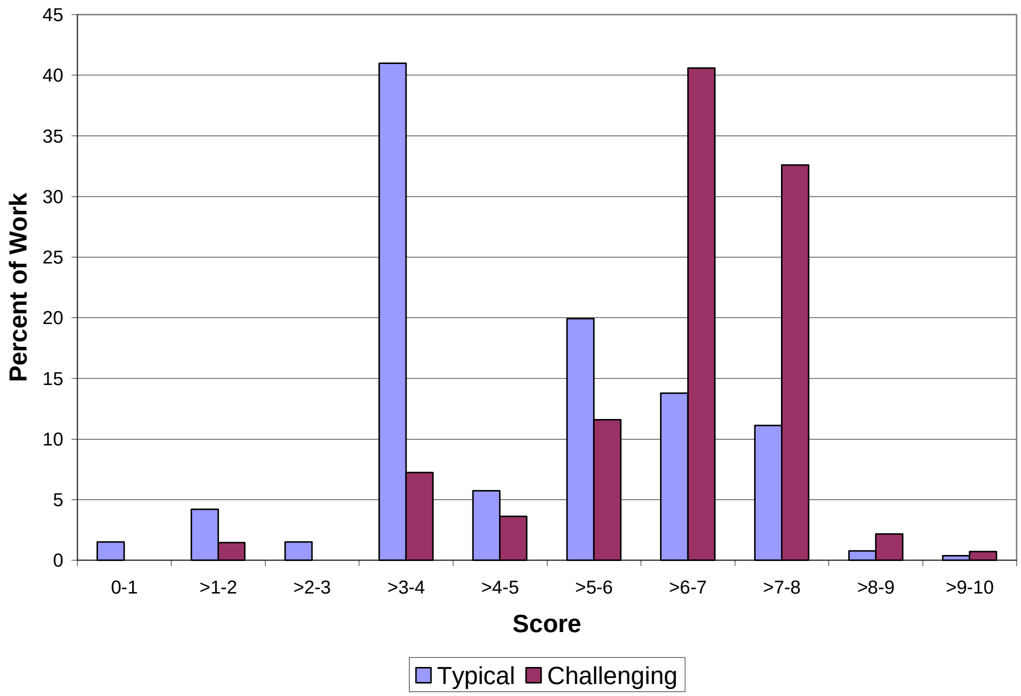
Figure 3.8: Score Distribution for Typical and Challenging Assignments in English/Language Arts



This graph shows that more of the typical assignments in English/language arts scored low on rigor and authenticity, and more of the challenging assignments scored high on this metric. This pattern of results is the one we hypothesized and is similar to patterns that appear in the Chicago data.

Figure 3.9 provides similar results for student work in English/language arts.

Figure 3.9: Score Distribution for Student Work on Typical and Challenging Assignments in English/Language Arts



These data, too, show the expected pattern. In general, student work produced in response to challenging assignments received higher ratings than work produced for typical assignments. The fact that more of the student work on challenging assignments received high scores shows that students' responses to challenging assignments were more complex than their responses to typical assignments.

Scoring Data in Mathematics

This section of the chapter reports the comparable set of analyses for mathematics assignments and student work. The text and exhibits in this section of the report discuss the reasonableness of the scoring data by showing low- and high-scoring artifacts, the distributions of scores for mathematics assignments and student work, and score data for typical and challenging assignments and the associated student work.

Examples of Low- and High-Scoring Assignments and Student Work in Mathematics

Figure 3.10 provides an example of an assignment that scored low on the combined scale for mathematics assignments.

Figure 3.10: Low-Scoring Assignment and Low-Scoring Student Work in Mathematics

Inverse Assignment

Complete problems 7-12 on page 302 and 15-32 and 35-39 on page 303 of your textbook. Show your work and use graph paper as needed.

xercises 15–22, write an equation for the inverse of the relation. See below.

$y = -3x + 5$ 16. $y = 2x - 3$ 17. $y = x + 4$ 18. $y = -5x + 9$

$y = 12x - 6$ 20. $y = -13x + 6$ 21. $y = 4x - 1$ 22. $y = 9x - 14$

xercises 23–30, sketch the function and its inverse in the same coordi-
e plane. Is the inverse a function of x? See Additional Answers.

$f(x) = x + 3$ Yes 24. $f(x) = -x + 2$ Yes 25. $f(x) = 3x + 4$ Yes 26. $f(x) = 2x^2 + 4$ No

$f(x) = x^2 + 1$ No 28. $f(x) = -x^2 + 3$ No 29. $f(x) = -x^2 - 4$ No 30. $f(x) = \frac{1}{2}x + 9$ Yes

xercises 31–34, sketch the graph of the function. Use the graph of f to
de whether the inverse of f is a function of x. See Additional Answers.

$f(x) = x + 1$ Yes 32. $f(x) = -2x^2 - 1$ No 33. $f(x) = x^2 - 2$ No 34. $f(x) = |x| - 1$ No

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Pg. 302 # 7-14 ; Pg. 303 # 15 - 32 1st 2 columns
35-39 1st column

7. { (5,1), (-3,4), (9,1), (-1,0) }
8. { (-4,0), (3,-4), (2,2), (1,2) }
9. { (1,3), (2,-2), (0,-1), (3,3) }
10. { (-4,1), (3,-2), (-6,0), (2,-3) }

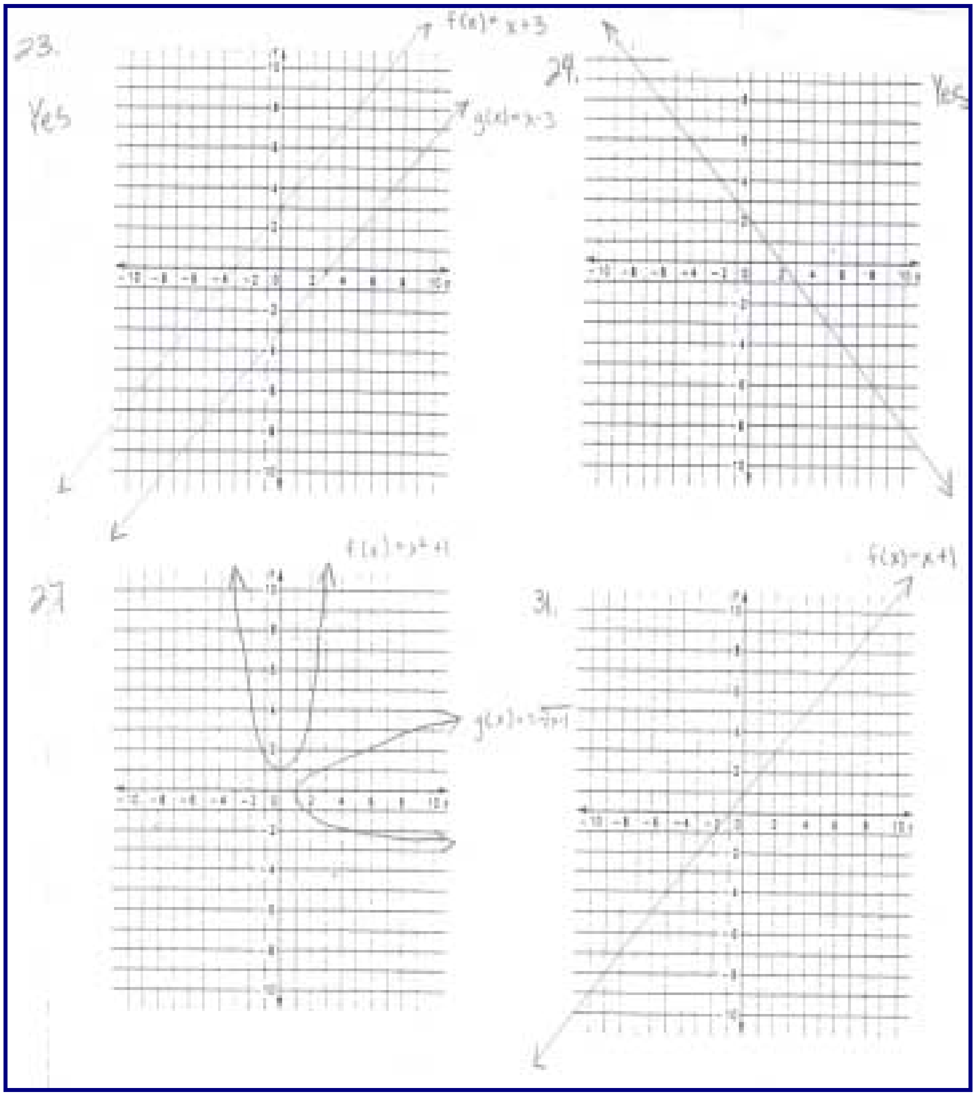
11. c
12. b
13. a
14. d

15. $x = -3y + 5$
16. $x = 2y - 3$
19. $x = 12y - 6$
20. $x = -13y + 6$

23.
24.
27. on graph
28.
31.
32.

35. $f(g(x)) = (x-9)+9 = x$, $g(f(x)) = (x+9)-9 = x$
37. $f(g(x)) = 2(\frac{1}{2}x + \frac{1}{2}) - 1 = x$, $g(f(x)) = \frac{1}{2}(2x-1) + \frac{1}{2} = x$
39. $f(g(x)) = -3(-\frac{1}{3}x + \frac{1}{6}) + \frac{1}{2} = x$, $g(f(x)) = -\frac{1}{3}(-3x + \frac{1}{2}) + \frac{1}{6}$

Figure 3.10: Low-Scoring Assignment and Low-Scoring Student Work in Mathematics (concluded)



To complete this assignment well, students have to invert a function and construct two-dimensional graphs of the function and its inverse. Though functions are among the important mathematical ideas that 10th graders encounter, this assignment requires students to demonstrate little or no conceptual understanding of functions, and the assignment itself is only tangentially related to the topic. In addition, the assignment requires no demonstration of problem solving or reasoning; it requires little more than a numerical solution or graph with no explanation for how the solution was reached. This assignment makes no attempt to create a problem situation that reflects the use of functions in a real-world application.

Though the student work that is featured in Figure 3.10 is competent, the work itself offers little evidence of complex understanding. It seems reasonable that scorers gave modest scores to this assignment and this student response.

Figure 3.11 provides an example of a high-scoring assignment and student response.

Figure 3.11: High-Scoring Assignment and High-Scoring Student Work in Mathematics

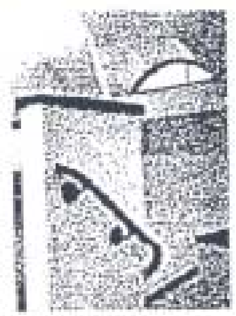
Vaulted Ceiling Assignment

Solve the problem, show your calculations, and provide a detailed description of your solution process.

The Vaulted Ceiling Problem

In the November 2000 issue of *This Old House Magazine* is an article about building a vaulted ceiling (which means curved) in a bedroom. At the end of the vaulted ceiling would be an "eyebrow window", which is a window that's curved on top with a straight bottom. Most modern eyebrow windows are just a slice off a circle.

The picture shows the inside view of an eyebrow window at the top of some stairs.

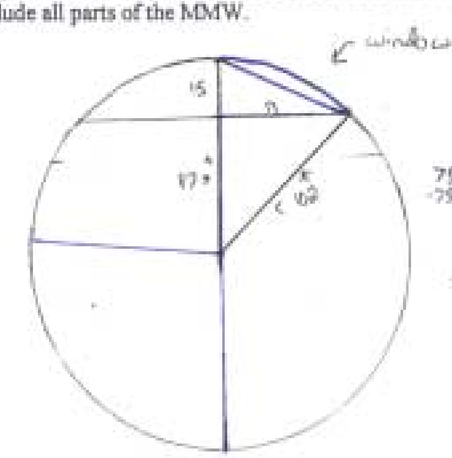


Here's the catch. They didn't know how wide the window was! Here's what they said in the magazine:

> [the contractor] needed to make the curve of the ceiling joists match that of the eyebrow window. When the unit didn't arrive in time, he was forced to rely on the manufacturer's promise that the shape would be equivalent to A 15-inch-deep slice off the top of a circle with an 8.5 foot radius.

Your job is to figure out how wide the base of this window will be. Use your circle facts and a compass and straight edge. Write your solution as a MMW. You do not need to word process the essay but you should be neat and clear in your presentation and include all parts of the MMW.

8.5 · 12 = 102 inches



$A^2 + B^2 = C^2$

$87^2 + B^2 = 102^2$

$7569 + B^2 = 10404$

$-7569 \qquad -7569$

$\sqrt{B^2} = \sqrt{2835}$

$B = 53.24$ = half of width

$53.24 \cdot 2 = 106.48$ = Total width

106.48 in or 8.87 ft

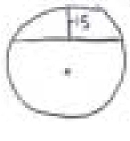
Figure 3.11: High-Scoring Assignment and High-Scoring Student Work in Mathematics (concluded)

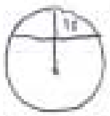
Problem statement - Find the width of an eyebrow window that is 15 inches high and part of a circle that has an 8.5 ft radius. Your results should be neat and clear in your MMW.

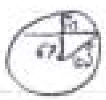
Process and Solution - First I converted everything into one unit of measurements. I chose inches. 8.5(ft) · 12 = 102 inches. That is the radius of the circle that the eyebrow window came from. Then you make a circle and draw a chord in it. This is the bottom of the window base of the eyebrow window. The height is 15 inches so mark that in. Connect that 15 inch line to the center making it a radius. This means the entire line is 102 inches. Minus the height (15 in) from the radius and you get the length of the line below the window, 87 inches. Next, draw another radius to either end of the chord. This line is 102 inches also. Part of the base of the window is one side of a triangle. To find the length of it, you use the pythagorean theorm $A^2 + B^2 = C^2$. So, $87^2_{in} + B^2 = 102^2_{in}$ B is the missing side. $7569 + B^2 = 10{,}404_{in}$, $B^2 = 2835_{in}$ $\sqrt{2835} = 53.24_{in}$ This is half the width of the base of the window. Multiply 53.24 in by 2 and you get the total width. The width of the eyebrow window is 106.48 in. or 8.8 ft.

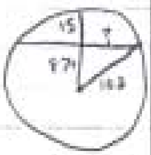
why?

requires rt. angle









Reflection - I really didn't learn anything new. I had used the P-theorm in the Sea Lion problem so I looked to see if I could use it here, and sure enough, I could. Using that I figured it out.

Whew!

Good!

* The triangle is a right triangle because when you connect the radius to the height, it bisects the chord, (height is in the middle), which means it bisects at a 90° angle. So you can use the P-theorm.

To complete the assignment in Figure 3.11 successfully, students have to demonstrate their understanding of the geometric facts and theorems related to circles and to argue clearly for their solutions. This assignment addresses a problem that is authentic and reflects the types of mathematical questions that are encountered by people in the real world. Although demanding only a moderate to low level of conceptual understanding of the domain, the assignment does require students to demonstrate a fairly high level of problem solving and reasoning within a problem setting that is likely to be relatively unfamiliar to most students. In addition, the assignment requires students to show their solution path and provide a detailed explanation and justification for the work.

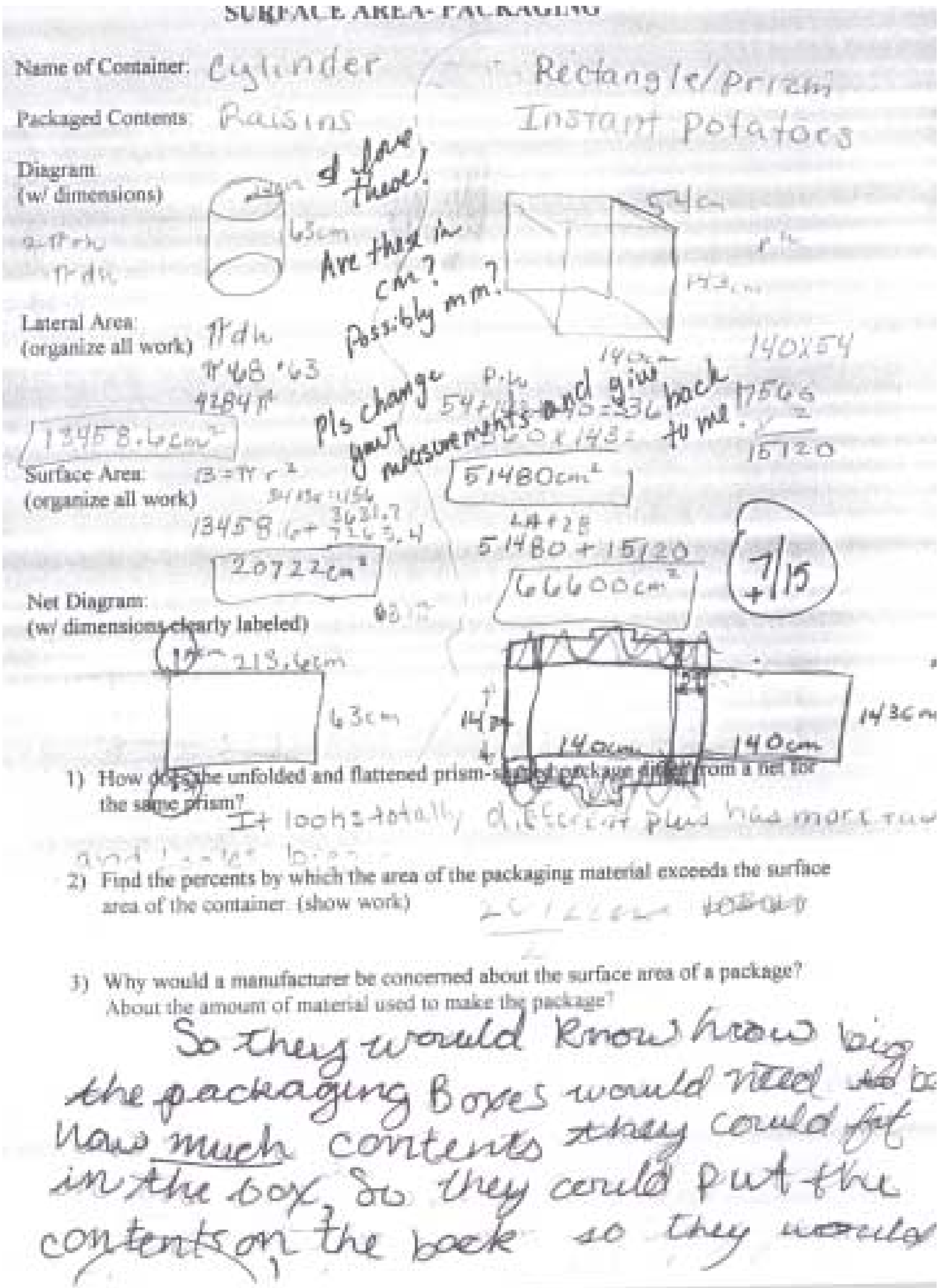
The student work that is featured in Figure 3.11 demonstrates clear conceptual understanding and procedural knowledge related to the relevant facts and theorems and is free of misconceptions and procedural mistakes. The problem-solving strategies and reasoning are appropriate and lead to the successful completion of the problem. The student work includes a solution path with complete and accurate explanation and justification of the conclusions. It is easy to appreciate the high marks scorers gave to this assignment and student response.

Figure 3.12 provides an example of teacher feedback in mathematics.

Figure 3.12: Teacher Feedback in Mathematics

Surface Area Packaging Assignment

Choose a consumer product and calculate the surface and lateral areas of packaging material for it. Create a net diagram and answer questions about area prisms.



SURFACE AREA- PACKAGING

Name of Container: Cylinder Rectangle/prism

Packaged Contents: Raisins Instant Potatoes

Diagram (w/ dimensions) I love these! 63cm Are these in cm? Possibly mm! 54cm 143cm

Lateral Area: (organize all work) πdh $\pi \cdot 68 \cdot 63$ 4284π 13458.6cm² Pls change your measurements and give back to me. 140x54 7560 15120 51480cm²

Surface Area: (organize all work) $B = \pi r^2$ 13458.6 + 7263.4 20722cm² 51480 + 15120 66600cm² 7/15

Net Diagram: (w/ dimensions clearly labeled) 213.6cm 63cm 143cm 140cm 140cm 143cm

1) How does the unfolded and flattened prism-shaped package differ from a net for the same prism? It looks totally different plus has more ...

2) Find the percents by which the area of the packaging material exceeds the surface area of the container. (show work)

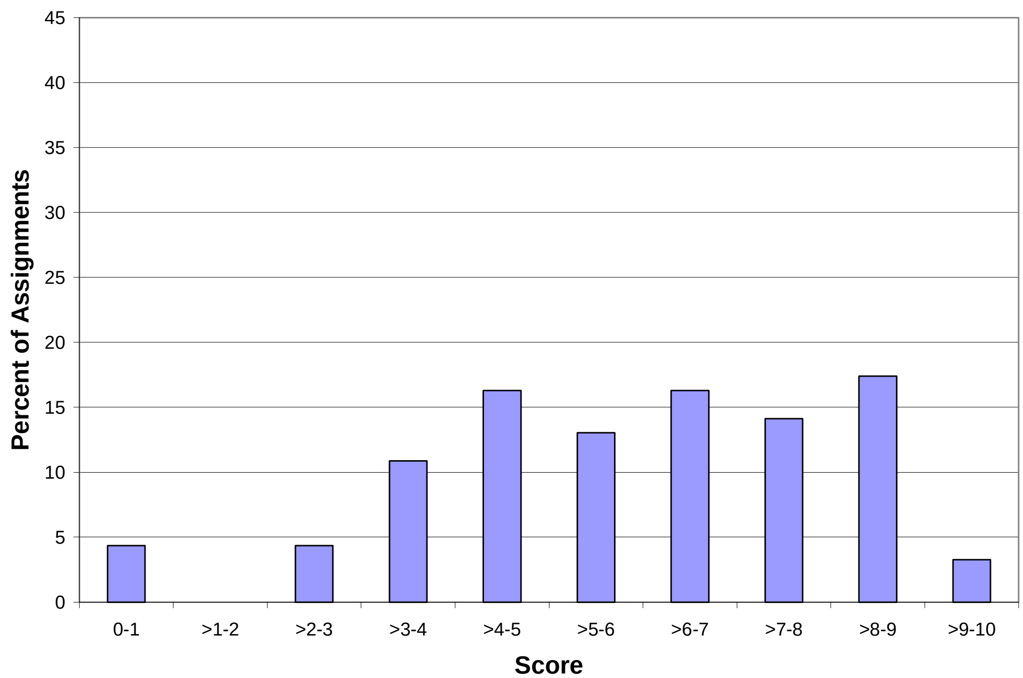
3) Why would a manufacturer be concerned about the surface area of a package? About the amount of material used to make the package? So they would know how big the packaging boxes would need to be how much contents they could fit in the box, so they could put the contents on the back so they would

Like the scores for teacher feedback in English/language arts, the scores for feedback on mathematics student work ranged from 1 to 4, with scores of 1 going to artifacts with no written feedback and top scores going to work with informative feedback. The feedback in Figure 3.12 got a score of 3; it provides information the student can use to improve this but not future work.

Score Distributions for Assignments and Student Work in Mathematics

Figures 3.13 and 3.14 show how scores are distributed on the combined score scale for mathematics assignments and student work. Figure 3.15 displays data on the feedback metric in mathematics.

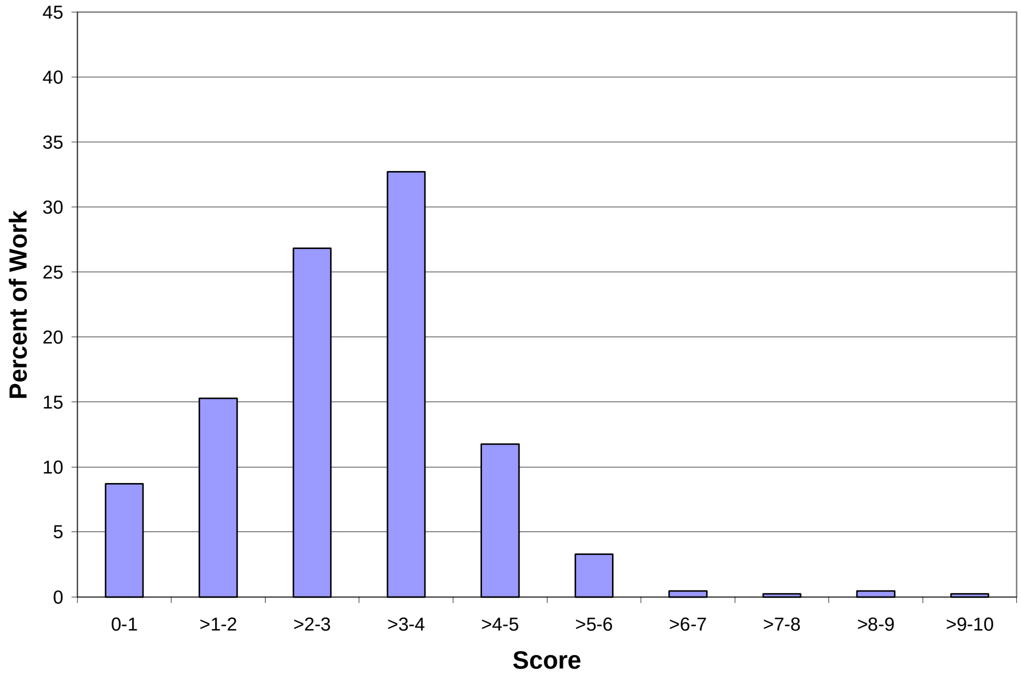
Figure 3.13: Score Distribution for Mathematics Assignments



The combined scale data for mathematics assignments in Figure 3.13 are fairly evenly distributed across the score points. There is a slight skewness to the distribution, with a higher percentage of assignments getting scores of 5 or above than getting scores of 4 and below. Nonetheless, there is sufficient room to measure change in teacher practice as schools make progress.

Figure 3.14 shows the data for student work in mathematics.

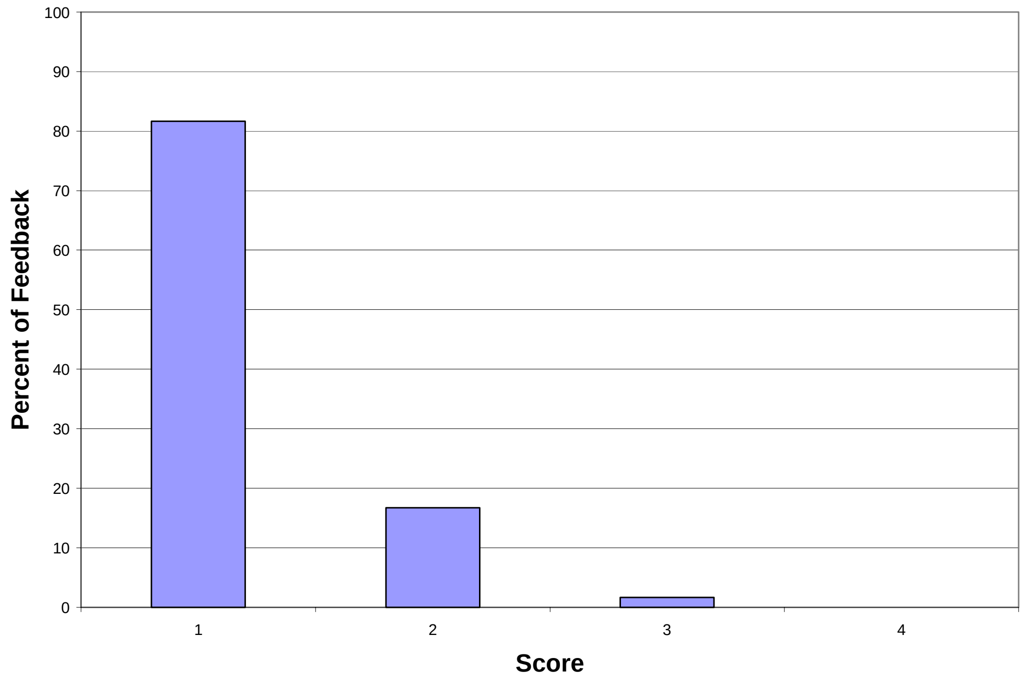
Figure 3.14: Score Distribution for Student Work in Mathematics



The combined scale data for student work in mathematics is highly skewed, with approximately 80% of the work with scores below 4. It appears that the current rubrics for assessing student work in math provide ample opportunity to document positive change as participating schools convert to small learning communities.

Figure 3.15 displays scorer data on the feedback rubric in mathematics.

Figure 3.15: Score Distribution for Teacher Feedback in Mathematics

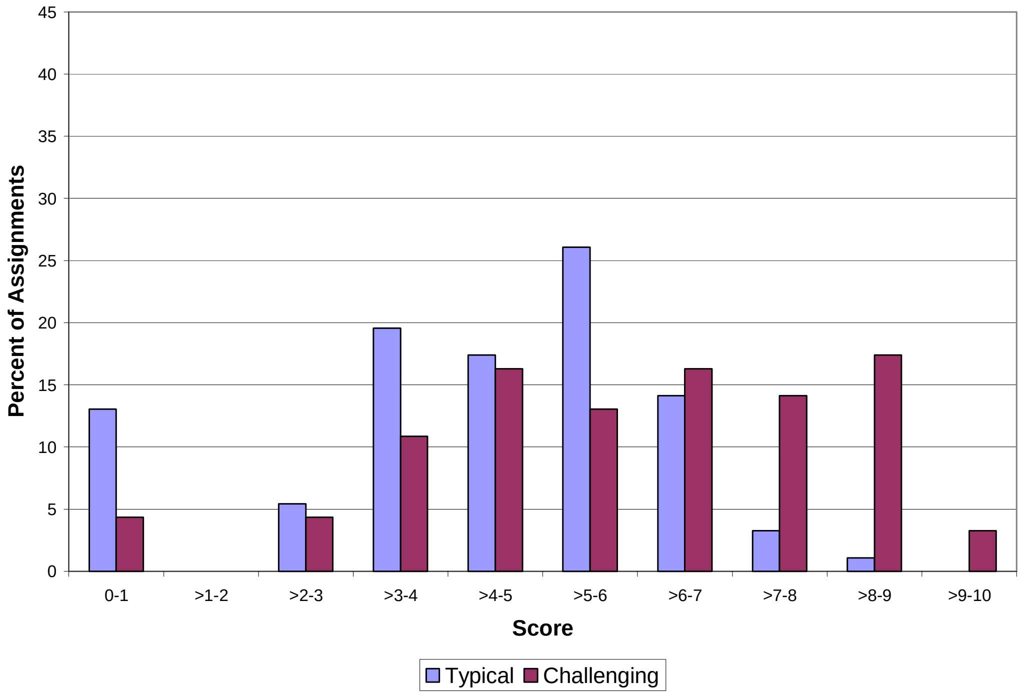


This display shows that less than 20% of the work in mathematics had any written feedback, and less than 2% included feedback that provided guidance for refining the work. The data show that students in participating classes got very little written feedback to inform possible improvements to their work. None of the work included feedback that provided guidance for strengthening future work.

<u>Scores for Typical and Challenging Assignments and the Resulting Student Work in Mathematics</u>

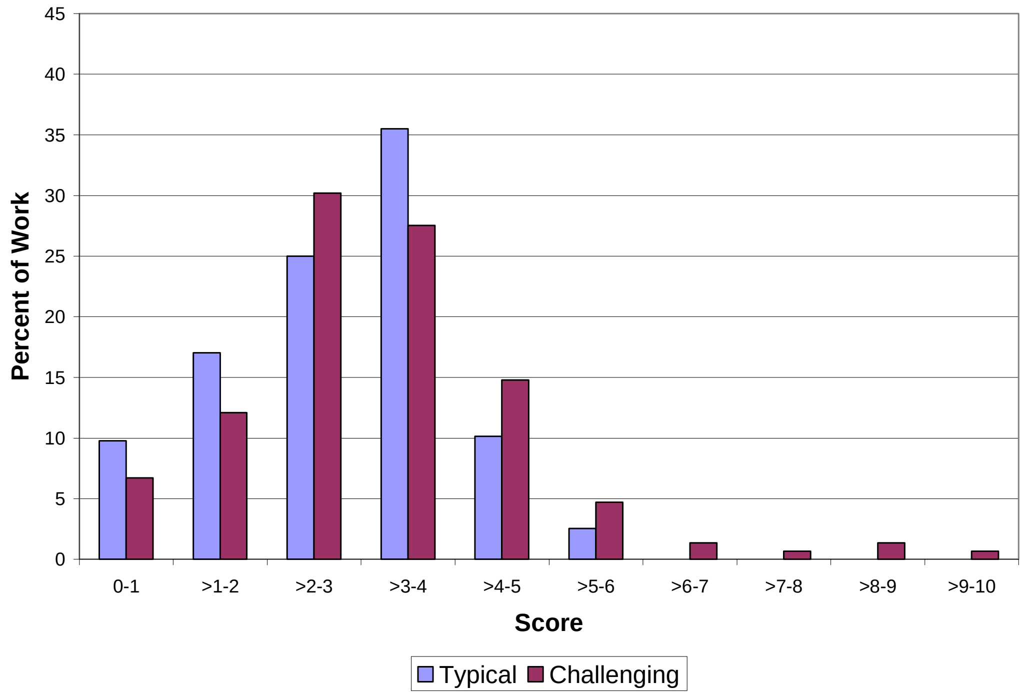
Our final examination of the data in this report considers combined scale data for typical and challenging assignments in mathematics and for student work done in response to typical and challenging tasks. Figure 3.16 shows the data for assignments, and Figure 3.17 gives the data for student work.

Figure 3.16: Score Distribution for Typical and Challenging Mathematics Assignments



Like the English/language arts data for typical and challenging assignments, the data in Figure 3.16 show the expected pattern. On average, the scores given to mathematics assignments that teachers regarded as challenging are higher than the scores given to typical assignments. Most of the mathematics assignments with scores of 7 or higher are from the challenging group.

Figure 3.17: Score Distribution for Student Work on Typical and Challenging Assignments in Mathematics



Though considerably less prominent than the distribution pattern seen in Figure 3.16, the pattern of results for mathematics student work in Figure 3.17 follows the same form, with more of the work associated with challenging assignments receiving higher scores than work responding to typical assignments. Very few pieces of mathematics work were scored higher than 6, and those that were are responses to challenging assignments.

Relating These Data to Other Information on Teaching and Learning

We continue to work with these and other data on teaching and learning in the Washington State schools. We are currently examining assignment and student work data in the context of other information about the characteristics of schools in this sample, the teachers who provided the assignments, and the students who supplied work. We are using complex modeling techniques to take these factors into account as we examine relationships between the rigor and authenticity of assignments, the quality of student work, and the utility of teacher feedback.

Importantly, we are relating the Washington data to achievement test data for participating students so we can discuss the relationships between assignments, the work students do in class, teacher feedback, and students' standardized test performance. In the Chicago work, researchers found moderate relationships between student work scores and standardized test results. They also found that students scored higher on standardized tests in schools where teachers gave more rigorous, authentic assignments. We discuss our upcoming analyses on these questions in Chapter 5.

Chapter 4: Summary and Conclusions

This chapter discusses the conclusions that we draw from our work thus far. It describes our work with English/language arts and mathematics teachers in foundation-supported schools in 2002-03 and with the assignments and work they provided. It describes the work of the teacher scorers and the data that resulted.

We start our discussion with the teacher participants and the assignments and student work they submitted.

- In 2002-03, teachers at foundation-supported schools in Washington State were willing to help us learn about teaching and learning in their schools. Forty-eight teachers provided samples of assignments at eight different times in the school year, along with samples of student work for three of those assignments. They also described their goals for instruction.
- The project team developed systems for capturing and archiving the assignments and student work that teachers provided. These systems adequately supported database development and the scoring process.

We draw several conclusions from our work with the rubrics and summer scoring.

- Subject matter experts and experienced teachers in English/language arts and mathematics helped us adapt Chicago's Authentic Intellectual Achievement framework to high school-level work and expand the measurement domain to include some of the unique goals of foundation-supported schools. We added rubrics to assess the choices students make about what they will study and how they will learn and the input and opportunity students are given to revise and improve their work. These constructs are important to teaching and learning in innovative high schools.
- In this inaugural year, we created training processes, training materials, and scoring procedures for assignments and student work in English/language arts and mathematics.
- With the help of 24 experienced teachers, we ran successful scoring sessions in both disciplines. Scorers gave ratings to assignments and student work in English/language arts and mathematics with agreement rates that are typical of performance assessment scorings with rubrics similar to ours and like those obtained by our colleagues in Chicago. Exact-agreement rates for a couple of the mathematics rubrics were lower than we would like, and we will concentrate on these in preparation for next year. We will examine our scoring and training materials for

these rubrics to see if we can strengthen the guidance we provide and increase agreement rates in 2004.
- Scorers in both disciplines said the rubrics helped them make important statements about the rigor and authenticity of assignments, the quality of student work, and the utility of feedback. Scorers said that the training and scoring sessions provided them with powerful professional development.

Finally, we draw conclusions from the analyses we have completed to date.

- Using the Many-Facet Rasch Model, we combined data across the different assignment rubrics and teacher scorers to create single estimates of the rigor and authenticity of classroom tasks in English/language arts and in mathematics. Similarly, we combined data across student work rubrics and scorers to estimate the overall quality of student work in each discipline. These modeling procedures worked well.
- Our examination of individual low- and high-scoring assignments and low- and high-scoring student work lends some credence to the results. Our post-hoc characterizations of low-scoring products are consistent with score-point descriptions at the lower ends of the scoring rubrics. Similarly, the qualities of high-scoring assignments and work are consonant with the meanings of upper-end scores.
- The assignment and student work scores that resulted from our procedures have reasonable, but not optimal, distributions. As we move forward in our work, we will examine the English/language arts rubrics to make sure they provide room to document the future progress of reforming schools. The clustering of scores for English/language arts assignments and student work in the upper ends of the score scale is not ideal in that the current scale may not provide room for teachers and students to demonstrate increased rigor and quality in the future. We expect the scores to increase as schools move forward and implement more innovative instructional approaches. The clustering of the scores in the lower range of the score scale for student work in mathematics is more consistent with presumed practice at schools planning for conversion.
- The distributions of scores for typical assignments and challenging assignments lend validity to the combined scores for assignments and for student work. On average, as hypothesized, more typical assignments have lower scores than challenging assignments. Similarly, on average the scores for student work responding to typical assignments are lower than scores for student work produced in response to challenging assignments.

This first year of research on teaching and learning in foundation-supported schools has yielded substantial methodological and measurement developments and provided promising results. Chapter 5 discusses the work that remains with our 2002-03 data. It also describes a new round of data collection in reforming schools in 2003-04.

Chapter 5: Next Steps

As we enter the new year, we will continue and complete the first-year data analyses, collect 2003-04 assignments and student work in a new sample of schools across the country, and make preparations for the 2004 scoring. For the 2002-03 data from Washington State, we will:

- Create reporting scales that have meaning for teacher participants and other school-based reformers.
- Examine the relationships among assignments, student work, feedback, and achievement test scores in Washington State.

For the 2003-04 data, we will:

- Collect assignments and work in 12 new small schools and 4 large schools planning for conversion.
- Refine scoring rubrics and procedures for the 2004 summer scoring session.
- Examine possibilities for studying non-written and other non-conventional work.

We discuss these efforts in turn.

Creating Meaningful Reporting Scales

We plan to examine the scoring data just presented, raw data from individual scoring rubrics, some of the intermediate results of the Many-Facet Rasch Model, and assignment and student work artifacts to create reporting scales that can be easily interpreted by participating teachers and other reformers. We plan to follow the approach taken by the Chicago Consortium researchers. Newmann, Lopez, & Bryk, (1998) collapsed their combined scales into 4-point reporting scales that described *extensive* rigor and authenticity, *moderate* rigor and authenticity, *minimal* rigor and authenticity, and *no* rigor and authenticity. They created a similar scales describing the quality of student work.

To create the 4-point scales for our data, we will need to iterate between scoring data and the artifacts to identify cut-points and score bands that support the inferences suggested by the four scale points. We will need to bring data analysts, subject matter experts, scoring data, and artifacts together to determine whether meaningful reporting scales can be created.

We believe the descriptive 4-point score scales will be more meaningful than the current 0 to 10 scales. We hope these scales will be useful to participating schools as they examine their efforts and make plans to improve teaching and learning. More generally, we hope these reporting scales will make the results of our work more meaningful to school-based reformers.

Examining the Relationships among Assignments, Student Work, and Achievement Test Results

Using data from the schools in Washington State, we will conduct correlational analyses to address the following research questions:

- What are the relationships among course and student characteristics (such as course level and students' reading levels) and the rigor and authenticity of English/language arts and mathematics assignments?
- To what extent are challenging assignments associated with more complex student work in English/language arts and mathematics?
- What are the relationships among results on jurisdiction-sponsored achievement tests and English/language arts and mathematics assignment and student work scores?

We will use hierarchical linear modeling techniques to examine the relationships between classroom characteristics (e.g., teacher background, student composition) and the rigor and authenticity of assignments. We also will examine the relationship between assignment characteristics and the quality of student work to determine if more complex learning opportunities prompt higher-quality efforts by students. Finally, we will relate assignment scores, student work scores, feedback data, and jurisdiction-sponsored standardized test results to each other to see how results on conventional achievement tests compare with what we learn about teaching and learning from analyzing classroom assignments and work. To do this work, we will match the current assignments and student work with demographic data and achievement test scores for students in this dataset. The results of these analyses will be presented at the American Educational Research Association conference in April 2004.

Collecting Assignments and Work Nationwide

In the fall of 2003, we moved beyond Washington State and began collecting assignments and student work from a national sample of foundation-supported schools.[12] Some of the schools in the national data collection have fairly innovative instructional programs, and we are beginning to think differently about the meaning of courses, assignments, and student work in reforming schools.

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[12] See the Technical Appendix of this report for a description of the national sample.

For example, at some of the participating schools, there are not English/language arts and mathematics courses; courses are multidisciplinary or theme-based. At others, teachers do not give assignments. At Big Picture schools, for example, students work on internship-based, semester-long projects that culminate in student products and public exhibitions. Students select and write proposals for their own projects with guidance from teachers and mentors. The curriculum is tailored to the needs and interests of individual students. At other participating schools, student work results from several students' effort. For instance, in New Technology Foundation schools, instruction is organized around class projects that require students to work in groups and produce group, rather than individual, products.

In cases like these, the project team has worked closely with grantees and school principals to develop sensible data collection plans. The plans have been developed to be sensitive to the schools' instructional programs while assuring that the data collected in these schools are compatible with data collected in other participating schools.

Refining Scoring Rubrics and Procedures

In preparation for the 2004 summer scoring, we hope to make improvements to our scoring rubrics and procedures, using the data in this report, our experience at the 2003 summer scoring session, and feedback provided by the scorers. Chief among these are improvements to the materials and processes that drive scorer agreement rates. We hope to obtain higher perfect-agreement rates in the upcoming scoring, particularly in mathematics.

Also important, but more vexing, are changes to correct some of the skew in the combined score distributions. We would like to leave more room at the top of some of the English/language arts score scales to document positive changes in teaching and learning for schools that continue to reform. Uncovering the likely sources of distributional difficulty will take some detective work. We will need to examine the scoring rubrics, raw score distributions, and some of the Many-Facet Rasch Model estimates to determine if there are ways to expand the upper ends of the score scales. If we discover possibilities to do so, we then will need to come up with feasible adjustments or corrections (Some improvements may be too cumbersome or costly.).

As we consider the refinements, we will need to decide whether suggested changes are likely to compromise comparisons between 2002-03 and later data. Some refinements to rubrics and procedures may be minor enough that they do not affect cross-year comparisons. Others may change the score data enough that new data would not be comparable to old data. There is a tension, therefore, between efforts to improve current methods and materials and assuring comparability over time. At this writing, we do not have sufficient information to make decisions intelligently on this issue.

Exploring Options for Studying Non-written Work

As mentioned above, several schools in the 2003-04 data collection have innovative instructional models. Some of these schools, as a matter of practice, ask students to produce work with media (e.g., video, audio, computer animations) that do not lend themselves well to the scoring processes with which we are familiar. Despite the fact that more and more schools are moving to innovative products, procedures to reliably score student work produced in alternate formats are not well understood.

Thus, this year, we will collect a sample of non-written and non-conventional work from participating schools so we can examine the feasibility of characterizing this work. We plan to share a sample of non-conventional work with scorers at the end of the 2004 scoring session and ask them to help us brainstorm about possible evaluation of the work. One of the central issues is whether these types of work provide information about student performance not currently captured by written work. We also need to be concerned with whether the unique information is useful and whether it is amenable to systematic evaluation within our framework.

We look forward to our continuing work with the 2002-03 data and with teacher participants in the 2003-04 schools. The questions raised in this chapter are interesting ones and we are eager to address them. We invite readers of this report to contact us for clarification of the information provided here or for additional detail. We welcome any and all suggestions for improving our methods and work.

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