Teaching Practices to Support 21st Century Skills: An Evaluation of the Intel® Teach Program Thinking with Technology Course

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EXECUTIVE SUMMARY

This report presents findings from evaluation research on the Intel® Teach Thinking with Technology course (hereafter referred to as "the Workshop"), conducted by Education Development Center, Inc.'s Center for Children and Technology in spring 2006. The Workshop is part of a portfolio of professional development programs supported by the Intel Education initiative. It is designed to prepare teachers to use freely available Web-based software (referred to in this report as "online thinking tools") that fosters students' use of various higher-order thinking skills. Each tool is intended to help students represent their thinking visually and to collaborate on both the creation and the analysis of those representations. More specifically:

- The *Seeing Reason Tool* helps students map cause-and-effect relationships and analyze complex systems.
- The *Visual Ranking Tool* helps students order and prioritize items in a list and then analyze and evaluate the criteria for their decisions.
- The *Showing Evidence Tool* helps students hypothesize and support claims with evidence, and then analyze and evaluate the criteria for their decisions.

This evaluation systematically looked at how teachers used the tools and concepts taught in the Workshop in their classrooms. The evaluation's research questions concerned teachers' use of the pedagogical concepts emphasized in the Workshop (the project approach, higher-order thinking skills, and curriculum-framing questions) as well as their use of the online thinking tools. Research questions also attended to the interaction of prior knowledge and other individual factors as well as contextual factors, such as school or district initiatives and local adaptations of the training, in terms of teacher follow-up.

This evaluation paid close attention to a group of teachers in three districts who were motivated to follow up on their Workshop experience and had the local resources in place to allow them to do so. The research design followed the implementation of a unit that incorporated one or more of the online tools. The knowledge teachers acquired from the Workshop and the range of instructional and technology practices they used in classrooms were documented and analyzed, with particular attention paid to five dimensions: use of the project approach, curriculum-framing questions, higher-order thinking skills, tool activities, and assessment. Using a rubric, multiple data sources (e.g., interviews, weekly activity logs, unit plans, student work and observations) were reviewed in order to assess the quality of unit implementation across these five dimensions.

Teachers were able to incorporate the concepts and tools from the Workshop into their classrooms, which spanned a wide range of ages and subjects. Furthermore, the Workshop was successful in providing teachers with project plans to improve students' higher-order thinking with the use of the online thinking tools. All teachers were successful in implementing some the Workshop's pedagogical concepts and thinking tool use, but few unit implementations were solid across all five dimensions. One central challenge for teachers was applying the practical knowledge of supporting higher-order thinking skills. The most successful unit implementations occurred in sites that provided *fertile ground* for the Workshop's teaching and learning strategies. In these sites, Workshop content was closely aligned with school or district initiatives, and a community of practice existed that valued not only technology integration but also the incorporation of higher-order thinking skills into the curriculum.

Key findings as to how the **pedagogical concepts** from the Workshop played out in classrooms included the following:

- Teachers believed in the importance higher-order thinking skills for their students; most did not have a practical and applied understanding of how to support higher-order thinking skills in the classroom.
- Teachers believed that the tools helped overcome students' preconceptions about learning and critical thinking.
- Teachers' self-rated prior knowledge about the project approach and curriculum-framing questions influenced the quality of unit implementation. However, teachers' self-rated prior knowledge of higher-order thinking skills did not influence the quality of unit implementation.

Key findings about how the **online thinking tools** were used in classrooms included the following:

- Tool use created opportunities for students to discuss, communicate, and collaborate, which teachers felt improved the quality of student work products.
- Engaging with and supporting students' higher-order thinking skills, and responding to student work generated by the tools, is challenging for teachers.
- Mastering the pedagogical concepts and how to use the tools are independent processes.
- Teachers usually used the tools in only one or two class sessions in order to complete an assignment; they rarely had students go back to the workspace.

Key findings regarding how the **educational context** shapes the use of the online thinking tools and pedagogical concepts in classrooms included the following:

- Districts that promoted teacher collaboration along with instructional techniques consistent with the Workshop curriculum provided more "fertile ground" for high-quality unit implementation.
- A highly valued aspect of all Workshop training was the time it afforded teachers to create project-based units and collaborate with colleagues.
- Each Master Teacher emphasized different aspects of the training, which influenced the way that teachers implemented the tools and concepts in their classrooms.
- Teachers adapted tool use and pedagogical concepts to fit students' needs in terms of their age and grade.
- While all core subject areas were represented in the study, reading and language arts units were the most common.
- Some teachers perceived tool use to be better suited for students of higher "ability levels."

Following the work of Pea (2004), the study found the tools to be effective *technological scaffolds*, providing opportunities for students to practice higher-order thinking skills, communication skills, and collaboration skills. Implementing the *social scaffolding* necessary to support students in this process poses a continuing challenging for teachers. For most teachers in this study, applying these skills to classroom practice was problematic; developing a conceptual understanding and practical and applied understanding of these skills are different.

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INTRODUCTION

This report presents findings from evaluation research on the Intel® Teach Program's Teaching Thinking with Technology course (hereafter referred to as "the Workshop"), conducted by Education Development Center, Inc.'s Center for Children and Technology (EDC/CCT) in spring 2006. This evaluation systematically looked at how teachers used the tools and concepts taught in the Workshop in their classrooms.

The Workshop is part of a portfolio of professional development programs supported by the Intel Education initiative. The Workshop prepares teachers to use Web-based cognitive scaffolding tools in their classrooms to support the development of students' 21st century skills. Intel Education defines this skill set with reference to the work of the Partnership for 21st Century Skills (2003) and the International Committee on ICT Literacy (2002), and places particular emphasis on developing students' abilities to think critically, communicate effectively, and collaborate. To accomplish these goals, the Workshop training engages teachers with two intersecting topics: project-based approaches to teaching and learning, and the use of Web-based software (referred to in this report as "online thinking tools") that fosters students' use of various higher-order thinking skills.

The Workshop encourages teachers to use the online thinking tools (which are described below) in a project-based context. The Workshop curriculum is structured to take participants through a step-by-step process of building a unit based on a single theme, or Essential Question. The unit-making process invites participants to consider how the online thinking tools present three different ways to have students grapple with the same question, or parts of a question, and to create a unit that encompasses the use of one or more of the tools. In addition to building teachers' technical skills and instructional strategies, the Workshop enables participants to produce completed unit plans—tangible resources that are tied to their instructional objectives and can be implemented in their own classrooms.

The Workshop is delivered using a train-the-trainer model. Senior Trainers, trained as a group by the Institute of Computer Technology (www.ict.org), are responsible for training district-

level Master Teachers[1] on the Workshop. Master Teachers are trained on all three tools in a 40-hour training, and are then encouraged to deliver the training to at least 10 teachers locally. The Workshop is modular and may include 24, 32, or 40 hours of face-to-face classroom time, depending on whether Participant Teachers are introduced to one, two, or all three of the online thinking tools.

The three Web-based tools addressed in the training are intended to help students represent their thinking visually and to collaborate on both the creation and the analysis of those representations. More specifically:

- The *Seeing Reason Tool* helps students map cause-and-effect relationships and analyze complex systems.
- The *Visual Ranking Tool* helps students order and prioritize items in a list and then analyze and evaluate the criteria for their decisions.
- The *Showing Evidence Tool* helps students hypothesize and support claims with evidence, and then analyze and evaluate the criteria for their decisions.

Conceptual Framework

The Workshop offers teachers with intermediate-level technology integration skills (Intel's Essentials Course or equivalent) an opportunity to enhance their skills, using free online tools. It was developed in part to provide a "next step" for teachers who completed Intel's Essentials Course, a 40-hour training focused on student use of productivity tools (i.e., Microsoft Office) in a project-based context. The Essentials Course was highly successful at orienting teachers toward a certain type of classroom technology integration; it emphasized putting the technology into the hands of students, tying technology use directly to project-based work, and providing teachers with the practice tools they needed to make classroom implementation of technology-rich unit plans realistic. However, the Essentials Course did not focus on helping teachers consider how technology use could have an impact on either the depth of students' content knowledge or the development of their higher-order thinking skills. Instead, it sought to help teachers integrate information and communication technology (ICT) tools into their

[1] Master Teachers trained with Version 1.0 or 1.1 of the manual have the opportunity to take a four-hour online course designed to familiarize them with the differences between Versions 1.0/1.1 and 2.0. An analysis of end-of-training data from this online course will be part of the next phase of the evaluation.

teaching to help their students conduct research and communicate their findings and ideas to others.

In contrast, the Workshop seeks to train teachers both in creating project-based learning contexts and in structuring students' use of a specific set of technology tools—the online thinking tools—to improve their higher-order thinking skills. After completing the Workshop, teachers return to their classrooms armed with a repertoire of instructional and curricular strategies to support project-based teaching and learning, and an understanding of how the online tools can best be deployed to scaffold and extend student learning.

Bringing ICT tools and instructional strategies together

Scaffolding is a critical component of teaching that helps students learn by building and connecting ideas through thought and exploration with the world. Pea (2004) presented two types of scaffolding to consider when implementing a technology-infused unit: social scaffolding and technological scaffolding. Social scaffolding includes promoting a positive learning environment that incorporates project-based approaches and communication to help students learn. This type of scaffolding corresponds to teachers being able to use the core concepts of the program, including higher-order thinking skills and the project approach. Technological scaffolding is being able to use the functions and capabilities of the software to enhance the targeted student skills, including exploration and thought within a new learning domain.

This view of scaffolding suggests that while implementing specific features of technology to effectively support students' emergent learning, teachers need to structure high-quality student learning experiences in the classroom. This will allow students to bring their ability to ask and answer questions into broader, deeper, and more complex territory than they could navigate on their own.

Teachers who participate in the Workshop face the challenge of scaffolding student learning in both domains, using the core instructional concepts as well as the technology resources. Last year's study (Culp, Pasnik, Wexler, & Meade, 2005) found that teachers may have a difficult time with envisioning and implementing a new instructional context while also having students

interact effectively with the online thinking tools. Thus, this year's study aims to better understand how teachers actually implemented the units they created in the Workshop. In addition, this study explores how the units—as implemented—actually aid student learning and where they may fall short, considering the units' use of the Workshop's pedagogical concepts and online thinking tools, as well as the interaction between the two.

Implications for the evaluation

This evaluation systematically investigated how groups of teachers in three school districts used the online thinking tools and pedagogical concepts taught in the Workshop in their classrooms after participating in the training. It follows up on many of the issues raised in last year's formative research (Culp et al., 2005), which concentrated on the obstacles and opportunities for improving program implementation. This study focused on the following research questions:

1. What knowledge do teachers take away from the Workshop about two key topics: supporting project-based learning, and using the tools to build students' 21st century skills?
2. Do teachers who follow up on their Workshop experience show evidence of their understanding of, and ability to act on, the knowledge gained from the Workshop?
3. When teachers who participated in the Workshop follow up on the training in their classrooms, to what extent do they (a) make use of instructional strategies associated with project-based learning, and (b) use the online thinking tools to support the development of students' 21st century skills?
4. How do contextual and individual factors interact with teachers' knowledge of the core concepts from the Workshop to influence whether and how teachers follow up on their Workshop participation?
5. What role does prior knowledge play in shaping what teachers take away from the Workshop and how they follow up on their experience?
6. How does change in instructional practice interact with particular strategies for using the online tools? For example, are teachers more likely to attend to one set of ideas in lieu of the other, or to follow up on both of these themes from the Workshop?

7. What local adaptations of the training (as reported by the trainer or participants) actually enhance the scope and quality of teacher follow-up to the Workshop, and which are impediments to program impact?

Organization of the Report

This report presents the results of an evaluation of teachers' unit implementation following the Workshop, version 1.0. After an overview of the sites and study participants and a review of methods and data sources, findings are presented, followed by a discussion of key results and conclusions.

SITE AND PARTICIPANT OVERVIEW

Districts

EDC/CCT worked in three study sites. These sites were selected because they had a critical mass of educators (a minimum of five teachers) who were committed to implementing units that involved the thinking tools during the study. Site selection is described in detail in Appendix A.

The three sites are school districts representing a range of educational environments and including a variety of educators. For privacy purposes, these districts will be referred to as District A, District D, and District F.

- District A is a small Midwestern district; the schools are in a rural area outside a small city. Teachers in this district were trained on all three tools. Every teacher in this district had taken Intel's Essentials Course.
- District D is a large Southwestern district; the schools are in a large urban area. Teachers in this district were trained on all three tools. Half the teachers in this district had taken the Essentials Course.
- District F is a small Western district; the schools are in a small town in a rural community. Teachers in this district were trained exclusively on Visual Ranking. No teachers in this district had taken the Essentials Course.

Teachers

A total of 12 educators from a variety of grades and disciplines were involved in the study: five from District A, five from District F, and four from District D. The grades included in the study spanned from Pre-K to 12, with the majority (nine) between third and sixth grade.

During the study, each teacher implemented one unit that used the thinking tools. These units represented a variety of subject areas: reading/English language arts (five), science (three), history/social studies (two), library/information literacy skills (two), mathematics (one), and psychology (one). Visual Ranking was the predominantly used tool among teachers across each district, while Seeing Reason was used the least overall. See Table 1 for an overview of all participants and the units they implemented.

Table 1. Participant Overview

		Subject/Area	Grade(s)	Unit Focus/Topic		VR	SR	SE	Attended Essentials Course?
District F	Teacher 1*	Library/media specialist	5–6	Information literacy	Cryptozoology			√	N
	Teacher 2	All subjects	5	Science	Biomes	√			N
	Teacher 3*	All subjects	5	Reading/lang. arts	Character traits		√		N
	Teacher 4	Math/science	6	Mathematics	3-D geometric shapes	√			N
	Teacher 5	Lang. arts/social studies	6	Social studies	So. American folktales	√			N
District A	Teacher 6	Library/media specialist	K–8	Reading/lang. arts	Enjoyment of books by William Allen White	√			Y
	Teacher 7	All subjects	3	Reading/lang. arts	Events and characters in *Ramona Quimby Age 8*	√		√	Y
	Teacher 8	All subjects	4	Reading/lang. arts	Compare and contrast characters/perspectives (*Blame It on the Wolf*)	√		√	Y
	Teacher 9	All subjects	4	Reading/lang. arts	Compare and contrast characters/perspectives (*Blame It on the Wolf*)	√		√	Y
	Teacher 10	Government, psychology	9–12	Psychology	Psychological disorders	√		√	Y
District D	Teacher 11	All subjects	Pre-K	Science	Butterfly life cycle	√	√		N
	Teacher 12	Reading/social studies	4	Reading/lang. arts	Sequencing; cause and effect (*Charlotte's Web*)	√	√	√	N
	Teacher 13	Social studies	11	Social studies	Modern history	+			Y
	Teacher 14*	Science	11–12	Physics	Inventions	√	√	√	Y

* Master Teacher
+ Teacher did a paper-based task modeled on Visual Ranking

METHODS AND DATA SOURCES

In this section we provide a brief overview of methods and data sources, along with a description of the Unit Implementation Rubric and specific unit examples for each element of the rubric. A complete description of the research methods and data sources may be found in the Appendices.

This study used a mixed methods design that incorporated qualitative and quantitative data collection and analysis. Researchers collected data from each teacher throughout the implementation of the teacher's unit. Six of the 14 teachers used the unit they had designed in the Workshop as part of the study. Of the eight who did not use the unit they developed in the Workshop, all but one of them had previously implemented that unit and created another one for this study.

The units were taught within a six-week period between April 10 and May 19, 2006. During that time frame, researchers collected several sources of data, including activity logs, interviews, site visits, unit plans, and student artifacts (see Appendix B for a full description). Weekly logs were completed, where teachers discussed the activities and focus of their unit during that week (a template is shown in Appendix C). Researchers interviewed teachers over the phone during the second and third week of the units and performed a site visit to each school during the fourth and fifth weeks. During the site visits, more extensive interviews and some classroom observations were performed; researchers also collected the unit plans and examples of student work and discussed them with teachers in artifact-based interviews. A full description of how each source of data was analyzed is contained in Appendix D.

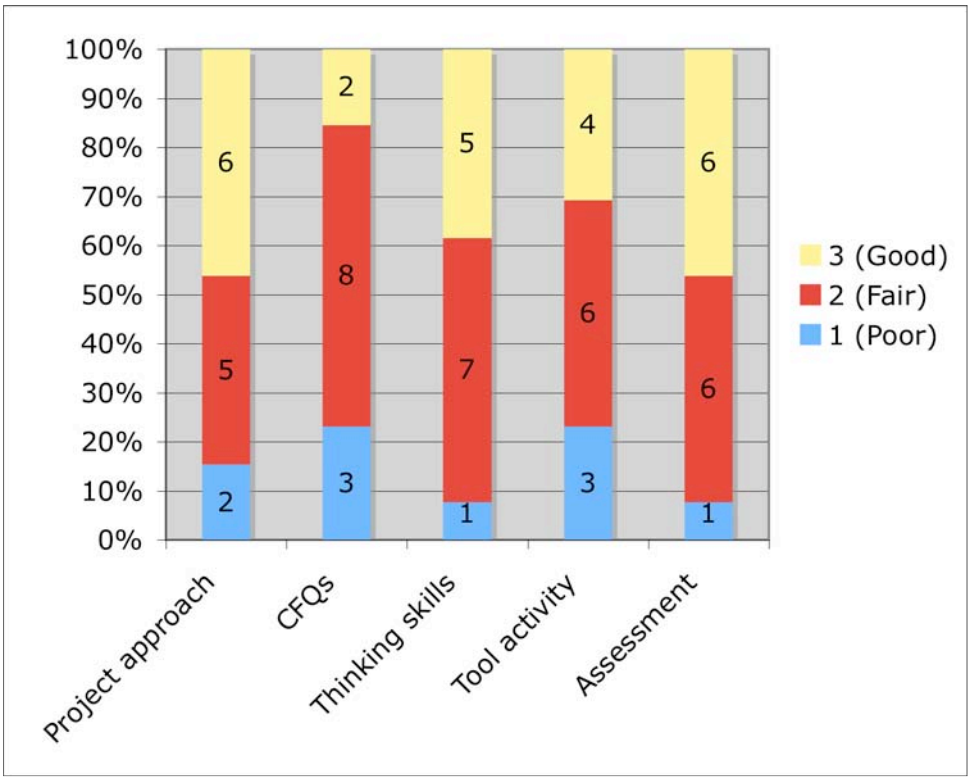
Unit Implementation Rubric

Researchers created a Unit Implementation Rubric to analyze the units and (especially) their implementation with regard to the goals of the Workshop in five distinct areas: higher-order thinking skills, project approach, curriculum-framing questions (CFQs), tool use, and

assessments. Units and their implementation were rated Poor (1), Fair (2), or Good (3)[2] in all five categories. Thirteen units were ranked; one unit was omitted (Teacher 6 in District A) due to the fact that the educator did not implement her own unit during the time frame of the study. Two researchers independently rated each unit; any discrepancies were then discussed, scores were agreed on, and final ratings were given.

About one-third or more of the units and their implementation were rated "Good" in each category except CFQs. At least three-quarters scored "Fair" or above in each category. Between one and three units were rated "Poor" in each category (see Figure 1, below).

Figure 1. Unit Scores on the Five Dimensions of the Unit Implementation Rubric



*Note: N = 13; Teacher 6's project was excluded since she had not completed a full unit during the time period of the study. She had used the tools prior and had only aided with Teacher 8's unit.

[2] An "Excellent" category (4) was not included because no unit implementations approached this level.

The remainder of this section describes each of the five dimensions of the Unit Implementation Rubric, with particular attention to the qualifications needed for a unit to be rated "Good" in a given section. Specific examples of units that received high ratings are given.

Unit Implementation Rubric: Higher-order thinking skills

To give a rating of "Good" in promoting higher-order thinking skills, researchers looked for several criteria throughout the teacher's unit. For example, higher-order thinking skills needed to be explicitly targeted; tool use should not have focused solely on factual information; students should have made connections between the subject material and the outside world and the higher-order thinking skills in the lesson need to have been age appropriate.

> *Example:* Teacher 4 implemented a unit that scored a 3 (Good) in promoting higher-order thinking skills. This teacher came from District F and taught sixth grade mathematics. Her unit focused on teaching students about 3-D geometry. She used the Visual Ranking tool to have students discuss and decide which of eight 3-D shapes would make for an optimal building, that is, one that had the most space inside (greatest volume) but would cost the least to cover (least surface area). After further exploration, students revisited and revised their initial rankings. Examples of student work using the Visual Ranking tool can be seen in Appendix E.
>
> Teacher 4 was able to build higher-order thinking skills into her unit in several ways. The tool use was not based only on the mathematical facts involved, but rather required students to incorporate those facts into their thinking and discussion. Students had to consider such math concepts as volume and surface and how these concepts would apply to a more real world project. This not only connects tool use with the subject area of math, it supports student understanding the mathematical principles by having students apply their ideas to a practical application in the outside world. The thought level was also appropriate for the age of the students, and it got them extremely engaged in the process. Teacher 4 noted that in addition to having high-quality discussions that exhibited higher-order thinking in the classroom, students continued to talk about their ideas in the hallway outside the classroom. As an end product, students created the 3-D shape they had selected to be optimal in terms of volume, surface area, and other practical applications. (Pictures of sample end products can be seen in Appendix F.) Higher-order thinking was critical in the end product because the rationale and argument behind creating the building was more integral than creating the building itself. The entire process led students to think in an applied, engaging, and critical manner for the duration of the project.

Unit Implementation Rubric: Project approach

For a unit to be rated "Good" at using the project approach, researchers looked for the elements outlined in the rubric presented in Module 3.08 of the Workshop Manual: The unit

needs to involve long-term goals and authentic applications outside of the classroom while students investigate compelling problems with authentic tasks and products. Students should take an active role as problem solvers, decision makers, investigators, and documentarians.

> *Example:* The Science unit about the life cycle of a butterfly implemented by Teacher 11 scored a 3 (Good) in using the project approach. This teacher is in District D and teaches Pre-K. She used Visual Ranking to discuss with her students the various stages of a butterfly's life and the order in which they occurred (egg, caterpillar, chrysalis, butterfly). Her unit also used Seeing Reason to discuss the factors that could influence a caterpillar's chances of surviving and becoming a butterfly.
>
> This unit used the project approach, even though Teacher 11's students were only in Pre-K. The project extended over several weeks, building on knowledge through real-world examples and discussion. The teacher brought in caterpillars and milkweed from local fields so that students could learn from observation as well as from pictures, books, discussion, etc. Due to her students' age, she had to adjust how much information they could process at one time, so the teacher revisited and discussed the unit often, which allowed students to better integrate what they learned. Having real caterpillars in the classroom gave students a chance to talk about what was happening in the caterpillars' lives each day and why it may be different in the wild. They saw caterpillars go through their life cycle and become butterflies. Students took an active role in learning by seeing the life cycle firsthand and doing related hands-on activities; learning science therefore had a direct real-world connection. Tool use complemented the project approach. Visual Ranking supported whole-group discussion of the life cycle. Students also discussed the environmental aspects of caterpillar growth, supported by Seeing Reason. This extended, applied, engaging learning shows how the project approach can be incorporated with tool use, even in a unit implemented with children as young as Pre-K.

Unit Implementation Rubric: CFQs

To rate a unit as "Good" in using CFQs, researchers looked at both the unit and classroom implementation. A teacher had to have clear questions outlined in her unit to guide the lessons, but he or she also had to show some evidence of using the questions in the classroom during the unit. The questions also had to be appropriately used, with each of the three tiers of questions focusing on the right level of information, as defined in Module 2.24.

> *Example:* Researchers gave the unit implemented by Teacher 2 a Good (3) in using CFQs. Teacher 2 teaches fifth grade in District F; she created a science unit that deals specifically with biomes in the environment. Her unit used the Visual Ranking tool to have students discuss which biomes they would save in the world if they could only save two. Examples of student work using the Visual Ranking tool can be seen in Appendix E.

Teacher 2 used the CFQs effectively throughout this unit. Her Essential Question was "How is everything connected?" Her Unit Questions were "What makes each biome essential to the world?" and "If the world's biomes were being destroyed, which two would you save?" Her unit also had numerous Content Questions that helped to guide the learning and thinking process. Her questions, on initial inspection, were at the appropriate level and clearly outlined. More importantly, the questions were also implemented well throughout the unit. She was able to discuss how she used each level of questions to guide the activity and motivate the students. She used the Essential Question to get students motivated to start thinking about researching the topic areas to discover broad ideas of how the world functions. She then used the Unit Questions to get students to apply their knowledge toward making decisions and arguments in thinking about the subject. She used the Content Questions as support for daily lessons and further fact-based activities. The unit also used the Essential and Unit Questions for consistent reflection and perspective throughout the unit, which led to making the information and end product more meaningful.

Unit Implementation Rubric: Tool use

To rate a unit as "Good" in its use of the thinking tools, researchers considered the following: the appropriateness of the tool use in terms of the goals of the activity itself; if the tool use supported students revisiting and revising their ideas based on new information, thoughts, and discussion; whether and how students were grouped; the discussion around ideas produced by tool use; and the appropriateness of the tool prompt and whether it was aligned to the tool's intent.

Example: The unit implemented by Teacher 8 scored a 3 (Good) in use of the thinking tools. Teacher 8 is in District A and teaches fourth grade. Her unit was designed for a literature class and involves thinking about characters and perspectives from a story. The unit used Visual Ranking to have the students discuss which characters in the story were the most trustworthy and why. Teacher 8 also used Showing Evidence to have the students form an argument as to whether the main character in the story was a good role model. Students could argue either way and were instructed to find evidence in the story to support their argument. Examples of student work using the Visual Ranking and Showing Evidence tools can be seen in Appendix E.

Since tool activities were a good fit with her goals and the curriculum, Teacher 8 was able to integrate the tools into lessons and activities she was already teaching. The teacher modified lessons to enhance students' thinking and learning via tool activities, using the tools in an appropriate fashion for her students' abilities and subject area. The students were able to engage in tool activities to enhance how they understood the story and thought about the characters. Teacher 8 guided this learning process by revisiting the tool activity and discussing what the students learned from it and how they were thinking about the story. Her unit used two tools in a separate yet related manner to further integrate ideas about the story. The students were deliberately grouped to discuss the activity; the prompts were used in a way that made the goals of the tool use very clear and structured for the students.

Unit Implementation Rubric: Assessments

To rate a unit as "Good" in assessments and feedback, researchers looked for units in which teachers provided multiple assessments during the unit implementation that addressed both process and end product. We looked for three things: feedback focused on content as well as student thinking; assessments given in multiple ways; and assessment of or feedback on participation and reflection in using the tools and in how the end products of the unit were created.

> *Example:* Researchers rated the unit implemented by Teacher 10 as 3 (Good) in assessments. Teacher 10 is from District A and teaches high school, specifically grades 11 and 12 for this unit. His unit was created for a psychology class that doubled for credit at the local community college. This unit used both Visual Ranking and Showing Evidence. With the Visual Ranking tool, students discussed which psychological disorder has had the greatest impact on American families and ranked 11 of them accordingly. They also had to use Showing Evidence to argue if a person with a mental illness should be mandated to seek therapy. They eventually used the tool to help produce a short paper arguing their position.
>
> Teacher 10's unit provided assessment and feedback throughout the unit. He gave informal assessments through observation during the research, thought, and discussion processes. While students used the Visual Ranking tool, the teacher helped them form their arguments in order to discuss them with the whole class. He also let students give feedback to one another. He monitored their participation and gave feedback on students' thought processes. He also had students complete a self-evaluation on how they learned and performed during the unit. In addition, he assessed both student work with the tools as well as the end products. He used rubrics to score student claims and evidence on both the Visual Ranking and the Showing Evidence tool. A final test was given to measure more formal knowledge, and a final paper providing an argument was assigned, as mentioned above. Using all of these methods helped students adjust and revise their work and their thinking along the way, and become conscious of their own learning and thinking processes.

FINDINGS

Findings related to the research questions presented in the introduction are organized into three sub-sections addressing the following topics: (1) how key Workshop concepts played out in classrooms, (2) how the online thinking tools were used in classrooms, and (3) what may have shaped how participants used the concepts and tools in their classrooms.

How Key Workshop Concepts Played Out in Classrooms

This section focuses on how three key Workshop concepts were integrated into unit implementation: *higher-order thinking skills* (findings 1.1–1.3), the *project approach* (finding 1.4), and *CFQs* (findings 1.5–1.6). Teachers paid attention to all of these elements of the Workshop training. In this section we detail how these elements were represented in the units as well as teachers' self-assessments of their prior knowledge in these areas.

Finding 1.1: Teachers believed in the importance higher-order thinking skills for their students; most did not have a practical and applied understanding of how to support higher-order thinking skills in the classroom.

Teachers were keenly aware of the importance of higher order thinking skills, and all of them said they were teaching these skills. However, there was little evidence that teachers explicit taught critical thinking skills, or targeted specific skills. Teachers believed they were promoting higher-order thinking skills during most weeks of the study but often had difficulty expressing a conceptual understanding of critical thinking and what it might look like in their classrooms, as well as applying it to their classroom practice. Moreover, teachers were not able to articulate the specific higher-order thinking skills they were targeting in the classroom. Generally speaking, teachers focused on global "critical thinking skills" or on skills related to their specific curriculum or standards, such as "sequencing" or "cause and effect." We believe this was due to teachers' broad perception of the components of higher-order thinking. It also may be that teachers have an abstract understanding of this concept but do not know how to apply it to classroom practice.

The majority of the units scored "Fair" (7) on promoting higher-order thinking, partly because of teachers' difficulty in expressing what constitutes critical thinking and how it can be translated into the classroom. In fact, teachers believed they were almost always aiding higher-order thinking skills, regardless of whether they were using the tools or not. This was probably due in part to their broad perspective of what constitutes higher-order thinking.

In writing the unit plans, teachers often had ambitious goals of how their unit would support critical thinking. Many teachers listed all the aspects of Bloom's or Marzano's taxonomies of thinking without relating them to the unit itself. When asked to discuss how higher-order thinking was represented in unit implementation, however, most teachers referred to higher-order thinking in the abstract.

A few teachers had a sophisticated conceptual and practical understanding of critical thinking and what it might look like in the classroom. For example, in her unit plan, Teacher 8 adjusted the higher-order thinking skills from Bloom's taxonomy in order to more closely match her goals and the ability level of her students, and she was able to discuss the specifics of what she thought critical thinking was for fourth-graders and how that related to her unit. Teacher 8 explained that she liked to use open-ended questions that allowed students to make inferences and solve problems based on what they learned in combination with their own life experience. She also incorporated such affective and motivational factors as having a positive attitude and working well interdependently with others as important behaviors to match her students' needs and abilities. She noted that the tools "make students think. If they don't have the visual thing in front of them . . . they let someone else do the thinking."

Teachers reported targeting "critical thinking" on the Activity Logs during 80 percent of the weeks of their unit. Results were virtually identical for weeks in which teachers used one or more thinking tools and weeks in which no tools were used. Across districts, there were some differences in how frequently teachers reported using critical thinking, but teachers consistently believed that they were targeting critical thinking in their teaching, with or without the tools (see Table 2). In two of the three districts, teachers reported targeting critical thinking more

often in weeks that they did not use the thinking tools. Overall, we saw little evidence that teachers were explicitly teaching critical thinking skills.

Table 2. Mean Percentage of Weeks in Which Teachers Reported Targeting Critical Thinking

	Tool Weeks	Non-tool Weeks
District D	95%	100%
District A	67%	77%
District F	83%	75%

Teachers, however, did report targeting some higher-order thinking skills, such as problem solving and collaborative learning, more frequently during the weeks where they used one or more thinking tools. Teachers also reported targeting some lower-level thinking skills less during weeks in which tools were used (see Table 3).

Table 3. Mean Percentage of Weeks in Which Teachers Reported Targeting Various Thinking Skills

	Tool Weeks	Non-tool Weeks
Basic knowledge acquisition	39%	71%
Recall	32%	47%
Problem solving	56%	49%
Collaborative learning	47%	38%

Finding 1.2: Differences in teachers' self-rated prior knowledge of higher-order thinking skills did not influence the quality of unit implementation.

We found that teachers' self-rated prior knowledge of higher-order thinking did not influence unit implementation. On a scale of 1–10 (with 1 being the lowest and 10 being the highest) indicating how familiar teachers were with promoting higher-order thinking before the Workshop, teachers' self-ratings were fairly high, ranging only from 5 to 10, with an average of 7. Teachers indicated that they were familiar with this concept through coursework or district initiatives. However, there was no statistical relationship between teachers' self-ratings of prior knowledge and the use of higher-order thinking skills in their projects. Teachers that rated themselves more highly did not necessarily have projects that supported critical thinking better than other teachers' projects. For example, Teacher 12 gave her prior knowledge a 9, but her

project was rated "Poor" in supporting thinking skills. Conversely, Teacher 7 only gave her prior knowledge a 6.5, but her project was rated "Good" in supporting thinking skills.

This finding emphasizes that teachers' self-reported abstract knowledge of thinking skills and taxonomies may not be sufficient for teachers to produce and implement units that employ critical thinking concepts. Teachers need to be able to transform their conceptual knowledge of higher-order thinking skills into practical knowledge – i.e., applicable units that support these skills. So, while prior conceptual knowledge of the skills may be helpful, it does not necessarily correlate with the practical knowledge of how to support these skills in the classroom. This suggests that practical knowledge about teaching these skills may emerge from the training as well as teachers' ensuing experiences. Thus, teachers with little prior knowledge can still be successful at promoting critical thinking and using the tools in their teaching after a productive Workshop experience.

Finding 1.3: Teachers believed that the tools helped overcome students' preconceptions about learning and critical thinking.

Some teachers observed that their students' perceptions of learning influence their desire to engage in critical thinking and project work. A small subset of teachers spoke eloquently about how the culture of schooling encourages students to discover the minimum amount of work they need to do in order to get highest grade they can. These behaviors run counter to an inquiry- and project-based approach, and make it difficult for teachers to engage students in critical thinking.

Using the tools helped shift student attitudes about higher-order thinking in a manner these teachers welcomed. Teacher 10 stated that higher-order thinking skills "take effect" when using the thinking tools, and students better learn the material. Previously, he said, his students who were in their senior year were just ready to get out of school and only learned to "regurgitate." The tools engaged the students in the activity through discussion and thinking. Moving outside of the regular "memorization and regurgitation" process led, he believed, to improved learning by the students. Teacher 13 similarly stated, "Kids are only concerned about getting their work done, not about what they learn."

Finding 1.4: Self-rated prior knowledge of the project approach may have influenced how well the units reflected the project approach.

Overall, the project approach was present in the units in this study; six units were rated "Good" on this measure, and five were rated "Fair." Only two units were rated "Poor." However, the data suggest that teachers who had little prior knowledge of the project approach could have difficulty in translating the concept from the Workshop into a productive unit that uses the thinking tools. This is especially important because the project approach provides the *social scaffolding* necessary for the technology use.

Teachers were asked to rate themselves on a 1–10 scale (1 = lowest, 10 = highest) in terms of their prior knowledge of the project approach. The two teachers whose units were ranked as "Poor" were the only two teachers to self-rate their prior knowledge below 5. The other teachers all rated their prior knowledge at or above 5 and had an average score of 7.5.

For example, Teacher 12's self-rating of prior knowledge was 4, and she seemed very unfamiliar with the project approach during the interviews. This lack of prior knowledge may have made it difficult for her to effectively use a project approach in a new unit. Her unit incorporated all three tools, but the tool use was isolated, did not connect to outside life, and did not build toward any product. In an example of a tool activity, the fourth grade students used Visual Ranking to put the events of a novel into the correct sequence. (Examples of student work using the Visual Ranking tool can found in Appendix E.) It may be that the project approach is not valued in this district; the teacher emphasized that the unit was guided by the state's standards and assessments, which were based on enhancing such skills as sequencing.

Finding 1.5: Most units included CFQs; however, teachers did not always report using these questions in their teaching.

Similar to last year's evaluation, we found that all the teachers used CFQs in their unit plans. Many thought that the CFQs acted as guides to help create the unit; one teacher who had participated in the Essentials Course said that identifying the CFQs is the first thing she does in planning.

Use of CFQs is the category in which units scored lowest on the Unit Implementation Rubric, with the fewest "Good" ratings and tied for the most "Poor" ratings. Most of the problems that teachers had with CFQs could be seen in how they viewed the purpose of their unit. Teachers who focused on thinking and discussion in their units used the questions as discussion guides, more so than the teachers who focused on the use of the tools or learning factual knowledge. Many of these differences can be seen in the discussion of the next finding.

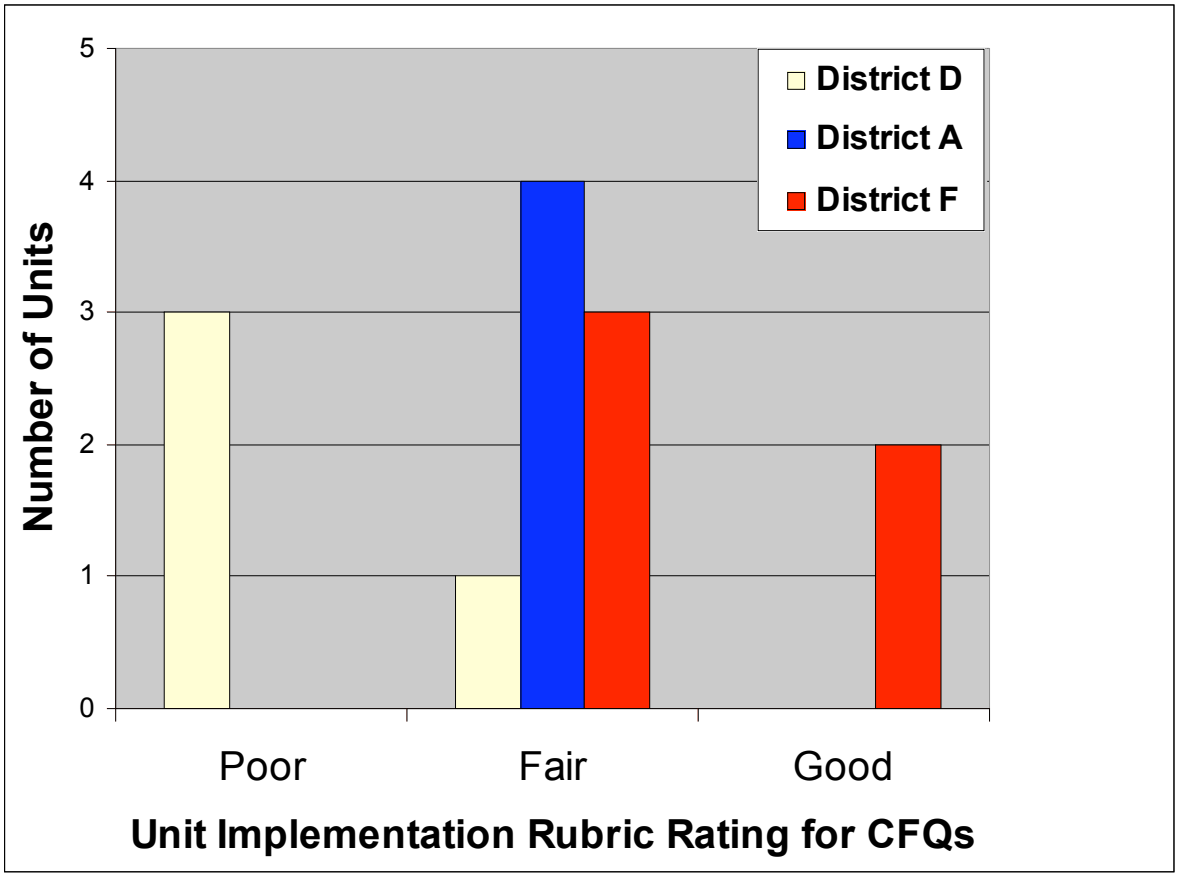
Finding 1.6: Prior knowledge and experience influenced teachers' understanding and use of CFQs.

There was a difference in the way that teachers understood, discussed, and used framing questions in each district. These differences are related in part to prior knowledge and in part to the emphasis placed on questions in the training.

In District F, teachers often referred to "driving questions." Three years prior to participating in the Workshop, this school had undertaken a school reform program that promotes improving student achievement through project-based learning, technology integration, and progress toward clear and measurable goals. In this model, "driving questions" are used to guide instructional units. Teachers in this district therefore had experience with using questions to help create and guide their units. District A also had experience with CFQs since all of the teachers had taken the Essentials Course previously.

Further analysis revealed a statistical difference between districts (see Figure 2). District F was rated the highest, with three units rated "Fair" and two rated "Good." District A was in the middle, with all four units rated "Fair" on their use of CFQs. District D scored the lowest, with three units rated "Poor" and one rated "Fair."

Figure 2. Number of Units Rated 1 (Poor), 2 (Fair), and 3 (Good) on CFQs, by District



These findings are supported by how teachers discussed CFQs. In District F, Teacher 4 said she "loved the Essential Question" because it captured students' attention, and she related back to it often. She used the other questions to guide the unit formation and day-to-day lesson planning. Similarly, Teacher 2 stated that her whole unit revolved around the questions; she used the questions to connect other units and keep the larger picture in perspective for students. Most of the teachers in District F mentioned that since they had experience with driving questions, the transition to using CFQs was easy and actually made the question-generation process more meaningful than before.

Teachers' experiences with the Essentials Course in District A may have helped them use the CFQs, yet evidence of CFQ use was minimal. This may have been because, according to teachers, CFQs or similar unit-framing questions were not emphasized in their district. In a typical response, Teacher 8 said, "I didn't use them as much as I should have," reporting that she shared the CFQs with students at the beginning of the unit but that they were not much used after that. Teacher 7 said that the Essential and Unit Questions were hard to develop, partially because these types of questions are not stressed in her school. However, each teacher in this district received a "Fair" rating since the questions were created to match the unit and, at a minimum, teachers presented the overall ideas and let the questions frame the unit.

Teachers' units in District D, however, where there was more focus on the application of the tools (discussed in **Shaping the Use of Concepts and Tools in Classrooms,** below) had the lowest ratings on CFQs. Teacher 14 (the Master Teacher of District D) admitted that though the CFQs are important, he did not consider them as critical—in terms of the Workshop content—as the tool application.

How the Online Thinking Tools Were Used in Classrooms

This section addresses findings related to how the online thinking tools were used in classrooms, and discusses how teachers perceived the tools and how tool use related to the pedagogical concepts presented in the Workshop.

Teachers who agreed to participate in the study committed to implementing a unit that incorporated the online thinking tools. Twelve of the 14 teachers[3] who completed the study used the tools with students. Of these, four were using the tools with students for the first time, and eight had already used the tools with students, either in stand-alone activities or in implementing the unit they had designed in the Workshop. Most of the teachers used Visual Ranking (11), more than half of them used Showing Evidence (7), and a third used Seeing

[3] Teacher 13 had an individual student use the tools in a library setting, and had the whole class do a paper-and-pencil activity based on Visual Ranking because she had no access to multiple computers for the class. Teacher 6 had not completed a full unit during the time period of the study. She used the tools with students earlier in the school year, working with Teacher 8 in implementing her unit.

Reason (4). Five of the units employed only one tool, five units used two tools (predominantly Visual Ranking and Showing Evidence), and two units used all three tools. Of the units that employed two or more tools, the second tool was often used very briefly as a secondary activity.

Finding 2.1: Tool use created opportunities for students to discuss, communicate, and collaborate, which teachers felt improved the quality of student work products.

The teachers who participated in the study almost unanimously viewed the tools as very valuable. Chief among the benefits they mentioned were that the thinking tools helped students learn how to think, create and defend their ideas, work on communication and collaboration skills, create products, write, and type.

Several teachers noted that the tools allowed them to teach certain ideas in a different and more effective and efficient manner. Almost every teacher had implemented a similar unit in previous years, without the thinking tools. These teachers stated that the tools were a good addition to their units, and they were pleased with how the students learned and performed with the tools. For example, Teacher 10 had done his psychology unit in past years before using the tools. He explained that in his experience, students only focused on one disorder—the one they had chosen to investigate—and were seldom engaged intellectually with one another. "But with the Visual Ranking tool, they were engaged. This process also promoted higher-order thinking . . . making students think, but in a fun way." Students were also able to research and discuss multiple disorders, rather than just focus and report on one.

Teachers said that using the tools in their unit helped students articulate their thoughts, leading to better discussions and collaboration. Teachers observed that discussions were involved and engaging, which may not have been possible without the help of the tools. Teachers believed that students were able to use the tools well in small-group collaboration and whole-class discussions. For example, since one of Teacher 7's goals for her third-graders was to improve their ability to collaborate, she intentionally grouped students together in a manner that would

be conducive to helping students communicate and work together. In other words, she provided social scaffolds in the learning process to help her students accomplish this goal.

Teachers thought that the tools were effective as a technological scaffold to help students write or produce an end product. An example is Teacher 5, who taught a literature unit to fifth-graders. Her unit used the Visual Ranking tool to discuss which character traits were most important for a main character in a traditional South American folktale. After reading folk tales and doing the tool activity, students wrote and presented their own folk tales whose main character possessed the top-ranked character traits chosen by the student. The teacher reported that the tools were useful in getting students to discuss the character traits, and that these traits were then incorporated into the students' stories better than they may have been otherwise. In fact, the teacher expressed disappointment in students' use of other folk tale elements that had been discussed with the class but had not been incorporated into a tool activity. On a more basic level, Teacher 7 commented that her third grade students benefited from the tool simply by gaining typing and writing experience, additional skills she wanted them to incorporate.

Another benefit mentioned by several teachers was that students learned how to better create and defend their ideas. For example, Teacher 4's Visual Ranking activity got students so engaged in thinking about the topic that she noticed students discussing and comparing ideas in the hallway after class. In pairs, students ranked various 3-D shapes according to which would be better than others for a city building and then had to justify their ideas. (See Appendices E and F for examples of student work using Visual Ranking and end products of the unit, respectively.) Students not only generated ideas in discussion with their partners but also discussed their ideas with the teacher, formally, and other classmates, informally, and then reworked their opinions and arguments. They also had to do a final defense in the form of a persuasive speech in front of the class. Students used math principles and real-life examples to create, discuss, and justify an argument, which was engaging and at least partially inspired by the use of the thinking tool.

All the teachers spoke about how using the online tools helped students' thinking skills, and the importance of this type of work. Teachers believed that engaging students in using the tools led to higher-order thinking.

Finding 2.2: Engaging with and supporting students' higher-order thinking skills, and responding to student work generated by the tools, is challenging for teachers.

A troubling trend emerged: teachers rarely paid attention to the actual nature of students' work with the tools (what we called "process artifacts"). Teachers often thought the unit activities were promoting higher-order thinking simply because the tools were being used. In a typical example, Teacher 5 spoke about the benefits of using Visual Ranking in terms of focusing students on the topic—the importance of character traits in South American folktales. The discussion and reflection engendered by tool use was as a means for creating the end product, students' own folk tales. Indeed, the teacher felt that the use of character traits in students' writing was very strong. The teacher did not examine student work with the tool during the unit.

When we asked teachers about the quality of the higher-order thinking generated by tool use, or the quality of the written comments within the tool space, for the most part teachers only spoke in generalities. Some teachers focused on surface issues, such as the amount of writing or the grammatical features of the writing. Other teachers did not look at the content of students' written comments or the quality of the evidence they presented at all; the fact that students engaged in the process was enough. Furthermore, feedback on students' thinking as evidenced in the tool use was not a standard feature in the majority of units. In addition, most teachers did not use the online feedback; only five teachers reported using teacher comments in the tool space, and students rarely revised their work in the tool space after feedback.

One reason for this trend may be that because teachers thought that tool use alone supported higher-order thinking skills, they may have lost focus on supporting these thinking skills within the unit. For example, Teacher 2's goal was to get students to learn facts about the different biomes (rainforest, desert, etc.) and to present those facts on a poster showcasing the biome

they selected as most important. Within the Visual Ranking activity, students had to provide reasons for the biomes they chose, but the teacher provided no feedback on or assessment of their responses. (See Appendices E and F for examples of student work using Visual Ranking and end products of this unit, respectively.)

Another example is the library/media specialist (Teacher 1), who used the Showing Evidence tool to have her Grade 5 students argue if a legendary creature, such as Bigfoot, actually existed. In discussing what she looked for in the students' Showing Evidence artifacts, she mainly focused on the *amount* of evidence. Teacher 1 did not discuss students' thought processes or source selections; only the completion of the activity was noted. The example of student work that met her expectations was a Showing Evidence output that included the minimum number of claims that she specified. The example of student work that exceeded her expectations had more claims, yet contained little evidence of student integration of knowledge or understanding.

There were two major exceptions to this pattern. When Teacher 3 (trained as a Master Teacher) reviewed the students' initial work and noticed that she did not get the desired responses to a Seeing Reason activity, she revised the prompt and also used the Teacher Comments feature to give students feedback. (Examples of student work using the Seeing Reason tool can be found in Appendix E.) Teacher 4 discussed with students their reasons for ranking, focusing on mathematical reasoning and use of mathematical language, and had students revisit their ranking more than once.

Finding 2.3: Mastering the pedagogical concepts and how to use the tools are independent processes.

In most unit implementations, the pedagogical concepts from the Workshop and the tool use were present in more or less equal measures. However, in some cases either the tool use or the pedagogical concepts seemed to dominate. One example is a unit that incorporated all three tools but lacked the desired pedagogical features (using a project approach, using CFQs, and focusing on higher-order thinking). Conversely, teachers who did not necessarily fully understand tool functions or features, or for whom the tools were not relevant because of lack

of technology access, may still have learned something about the project approach or higher-order thinking skills.

An example of the former (tool use without Workshop pedagogy) is Teacher 12 in District D, whose unit incorporated all three tools. Teacher 12 used the Visual Ranking activity as a means for students to practice sequencing (ordering the events of a novel; see Appendix E), part of the state's language arts standards. Seeing Reason was used to show cause and effect, another state language arts standard. Students used Showing Evidence to answer questions they generated, such as "What makes a good friend?" Teacher 12 was able to understand the technology, went out of her way to bring students to the computer lab despite scheduling complications, and managed the students in the computer lab without the help of the computer teacher. However, the project approach, CFQs, and the promotion of higher-order thinking skills were not implemented.

An example of the latter (pedagogical understanding without tool use) is Teacher 3 in District F. She is a Master Teacher and had used Visual Ranking with her grade 5 students in several units throughout the year. During the study, she used the Seeing Reason tool for the first time. The students took character traits from a story and attempted to draw arrows to show how the traits were related. The students had a hard time understanding the exercise even after the teacher revised the prompt and gave them feedback. Tool use in this unit was rated "Poor" on the Unit Implementation Rubric, yet the rest of the categories were rated "Good" or "Fair." The teacher was able to use the project approach, support thinking, and use the framing questions within her unit.

Finding 2.4: Teachers usually used the tools in only one or two class sessions in order to complete an assignment; they rarely had students go back to the workspace.

In this study, teachers often used the project approach in order for students to create one final end product. In this approach, the thinking tools were used as a step to help reach that goal. They were viewed as an exciting activity to incorporate into the units and to enrich discussion; however, the tools were not closely linked to teachers' instructional goals or to the end

product. Most often, the tools were used in one or two consecutive class sessions; students rarely went back to the workspace over time.

Shaping the Use of Concepts and Tools in Classrooms

There was a noticeable difference in the amount of tool use and the quality of unit implementation across the three districts. District D used, on average, one or more tools during 85 percent of the weeks in their unit, while District A used the tools in 46 percent of the weeks, and District F in 43 percent. This pattern across districts was consistent across each of the three thinking tools (see Table 4).

In order to better understand these differences—and the context within which teachers transformed their learning from the Workshop into unit creation and implementation—we examined influences on teachers' pedagogical concept and tool use. Sources of influence included teachers' Workshop experience (findings 3.1 and 3.2), the school or district environment (finding 3.3), and factors relating to students (findings 3.4–3.6).

Table 4. Percentage of Weeks in Which Tools Were Used in Units (averaged across teachers)

	Visual Ranking	Seeing Reason	Showing Evidence
District D	72%	58%	39%
District A	22%	0%	29%
District F	26%	5%	12%

Finding 3.1: Districts that promoted teacher collaboration along with instructional techniques consistent with the Workshop curriculum provided more "fertile ground" for high-quality unit implementation.

Several contextual characteristics exist within a school or district that together help create a *fertile ground* for teachers to better learn and implement units that incorporate both the thinking tools and the pedagogical concepts of the Workshop. Two of the major characteristics that may promote this fertile ground include a critical mass of trained teachers in a school and a school or district context that is consistent with the Workshop intent.

Having multiple teachers in a school or district that are willing to help one another and work together to create units and discuss positive implementation can help teachers understand the tools and concepts and how to use them productively in a unit. In this study, unit implementation quality was higher in the two districts that exhibited these characteristics. For example, District A had a critical mass of teachers: Four teachers were in one school, and the fifth teacher was in the adjacent high school. The sharing and cooperative atmosphere helped teachers in both creating and teaching units that used the tools and concepts. The four elementary school teachers all created reading/literature units. This consistency allowed them to work together and share ideas about matching their units to both the objectives of the school and the students' needs. For example, Teachers 8 and 9 created a unit together; they implemented it independently but shared ideas and discussed the unit throughout. Similarly, Teacher 6 as a library specialist helped Teacher 7 implement her unit and helped her students with the technology. An opposing example is District D, whose teachers were in different schools. Notably, teachers did not mention cooperation or collaboration when they spoke of unit creation or implementation.

Fertile ground can also be established when the objectives of the district coincide with the concepts emphasized by the Workshop. In such districts, connections between the Workshop and other school or district instructional initiatives can be made explicit to teachers. These teachers will also likely have some familiarity with the concepts put forward in the Workshop. This allows teachers to more quickly see the relevance to their classrooms. Workshop initiatives being aligned with district initiatives reinforces what teachers have learned previously and influences how they teach the unit. For example, the teachers in District F, with their school reform experience, stated that they easily learned the CFQs and were able to describe how they used them well. Their prior experience with similar concepts, as well as being in a district that supports using such questions, may have contributed to their high unit ratings on CFQs.

Finding 3.2: A highly valued aspect of all Workshop training was the* time *it afforded teachers to create project-based units and collaborate with colleagues.

One feeling shared by teachers across districts was that having time to create instructional units and work with colleagues is invaluable. Teachers said they rarely receive time to plan, and the time they had during the Workshop directly contributed to the likelihood that they would try to use the tools with students.

Constructing a unit during the Workshop not only got teachers thinking about tool use and pedagogical concepts, it prepared them for implementation during the school year. Some teachers said they were more likely to try to use the tools because the unit was "ready to go." Their main concern with the tools was the time required to make more units that incorporated both the tool and the pedagogical concepts.

In creating the units during the Workshop, teachers were also able to get ideas from one another and from the Master Teacher. This process was enhanced in two districts that had a critical mass of colleagues from one school (discussed in detail in finding 3.3, below).

Finding 3.3: Each Master Teacher emphasized different aspects of the training, which influenced the way teachers implemented the tools and concepts in their classrooms.

Following last year's finding that "trainers often tailor or modify the Workshop agenda to accommodate the interests and expectations of local participants or to accommodate logistical constraints," we found that these modifications impact the way that Participant Teachers implemented the tools and concepts in their classrooms. Master Teachers' own perspectives as well as what they choose to emphasize can have a strong effect on what the teachers take away from the training and how they create and implement their units.

For example, in District D, the training emphasized technological proficiency and tool use. Accordingly, some teachers in this district used the tools with less regard to trying to promote the project approach and higher-order thinking skills and to use CFQs. This trainer's emphasis may have led to the vast differences in frequency of tool use shown in Table 4 above (p. 27). In addition, when averaging scores across all five dimensions of the Unit Implementation Rubric, three of the teachers' units in this district had the lowest scores of any units in the study, each

averaging below 2 (Fair). The training's emphasis on using the technology clearly had some influence on the amount that teachers used the tools in their units, but it may also have detracted from how teachers understood and used the Workshop's pedagogical concepts.

In contrast, in District F, where teachers only learned Visual Ranking, there was a greater emphasis on using the underlying pedagogical concepts. These teachers used the thinking tools significantly less, but they used them as one part of larger learning goals. All the teachers in District F found the tools to be beneficial for student learning. The pedagogical concepts were well integrated into their units, and there was not one "Poor" rating outside of tool use in any of these teachers' units.

Finding 3.4: Teachers adapted tool use and pedagogical concepts to fit students' needs in terms of their age and grade.

Although teachers had a difficult time defining what exactly constituted higher-order thinking skills for their students, there were noticeable differences in how thinking abilities of younger and older students were described. Teachers of younger students believed that, due to developmental issues, their students' higher-order thinking skills were more restricted. This perception influenced how teachers applied the tools in their classrooms. Many teachers matched the perceived abilities of their students to how they used the tools to promote higher-order thinking.

Teacher 11 is a good example, albeit extreme, since she teaches Pre-K students. There is a major emphasis in her Pre-K classroom on language development. Using open-ended questions and discussion appealed to her, as she could promote language development at the same time as higher-level thinking, which she considers important, even at this young age. She used Visual Ranking and Seeing Reason, adapting their use to the ability level she perceived her students having. She led a whole-class discussion while she manipulated the tools herself. She used pictures and colored cardboard in the Visual Ranking and Seeing Reason activities to help give the children a visual display, since their reading, attention level, and technology experience were not sufficient for them to be able to work with the tools independently.

At the other end of the continuum, Teacher 10 defined higher-level thinking for his high school students as requiring much more, including "meaningful use of knowledge . . . discussing and thinking . . . backing up their ideas." He also discussed how connecting ideas to the outside world was critical, as well as students focusing on *why* and not just the factual information. Accordingly, tool use in his classroom was more student-led; he urged students to challenge one another and even "talk trash"—making competitive statements in a joking manner—to motivate idea exchange and justification. The Visual Ranking exercise he created was based on helping students understand how concepts function and relate. He had students use the Showing Evidence tool not just to find evidence for an argument but as a means to create a coherent discussion in a short paper.

Finding 3.5: All core subject areas were represented in the study; reading and language arts units were the most common.

Perceptions of how the online thinking tools can be used within each subject is an important issue, since teachers who cannot see the relevance of the tools to their subject may be more reluctant to use them. In this study, we found that teachers were able to integrate disciplinary demands with the pedagogical ideals of the Workshop, and use the tools accordingly. The teachers in this study taught a tremendous variety of subjects with various emphases (see Table 1). However, it should be noted that we searched for volunteers who were willing to implement a unit; volunteers may be more confident teachers in general, or they may be more confident about the Workshop ideas and tool use.

Similar to last year, reading and language arts were the most popular subject area for creating a unit that used the tools, representing almost half the teachers in this study (6 of 14). This supports last year's finding that teachers of other subjects may be more reticent about attempting a project such as that of Teacher 4, who implemented a fifth grade math unit that scored the highest overall rating on the Unit Implementation Rubric.

The teachers in this study were able to find ways to use the tools for the elementary grades and in mathematics with little difficulty, in contrast to last year's findings that stated "questions about the relevance of the tools for elementary-grade students and for mathematics . . .

persist." The importance of ensuring that teachers of younger children and teachers in areas such as math are comfortable with the tools and concepts, and see relevant applications, however, is still critical so that teachers will be willing to create and implement units and discover how effective the tools and pedagogical concepts learned in the Workshop can be.

Finding 3.6: Some teachers perceived tool use to be better suited for students of higher "ability levels."

Although most teachers participating in the study did an extraordinary job of using the tools to reflect the abilities and interests of their students, some are still concerned about tool appropriateness and usability. A substantial minority of teachers voiced the belief that the tools and related activities are better suited for higher-achieving students. This is related to last year's findings that some teachers will have reservations about using the tools if their students are too young or do not have the skills to successfully complete a unit that incorporates the thinking tools. Part of the reason for these reservations is that teachers may not have a rich practical understanding how students in their grade levels can achieve higher-order thinking through technology use. Ensuring discussion in the Workshop of what constitutes critical thinking for each age may help alleviate these concerns, though teachers still may worry about variation of skill levels within a grade.

For example, Teacher 10 stated that his students were "seniors taking this for college credit—they are the smart kids." Teachers 4, 12, and 14 also taught this unit to their more advanced classes. Several teachers mentioned that their units ran smoothly and effectively because their students were more advanced and could handle the thinking and technology better. This may lead teachers to ignore the fact that the units may work as well or better with students who are not high achievers.

Teacher 13 used the tools with one student who the teacher said was "bored" in class. This student did not find the class materials and assignments challenging, and therefore, according to the teacher, did little work in class. Teacher 13 created an independent assignment for the student, which the student completed in the library. The student was able to use the tools on her own and became very engaged in the project. Initially, Teacher 13 thought that the tools

were more appropriate for higher-achieving students, such as this one. However, later in the study, the teacher conducted a brief paper-and-pencil version of Visual Ranking with the whole class, discussing inventions most important to today's society. Teacher 13 commented:

> [T]he last school I was teaching was in the suburbs and I had kids who were capable of thinking, but I kind of took it for granted that kids here weren't. . . . I used their language barriers as an excuse, and it isn't an excuse. They can think just like other kids can think. So it kind of opened my eyes that I should be a little bit more open minded. . . . It taught me that you have to expect things from your students in order for them to perform.

DISCUSSION

This evaluation paid close attention to a group of teachers who were motivated to follow up on their Workshop experience and had the local resources in place to allow them to do so. This study allowed us to document and analyze the knowledge that teachers acquired from the Workshop and the range of instructional and technology practices they used in classrooms.

According to the manual, the Workshop's overarching goal is, "Participants will leave the Workshop with strategies and project plans to improve students' higher-order thinking with the use of free online tools." Last year's evaluation (Culp et al., 2005) suggested that this goal was being achieved; teachers were indeed leaving the training with ready-to-use project plans. This is supported by findings in the current evaluation, which showed that teachers valued—and implemented—the project plans they created. Just as importantly, last year's report raised questions about the likelihood of teachers returning to the tools over time, implementing other projects similar to those they created in the Workshop, and focusing on higher-order thinking skills. These questions of classroom implementation and follow-up were central to this year's investigation.

As is evident from the findings in this year's report, this group of teachers enthusiastically implemented the units they created in the Workshop. Some teachers went beyond that to create new activities that incorporated the tools into existing units. They did this in a variety of grade levels and subject areas. Teachers attended to both the *pedagogical concepts*—using a project approach, considering higher-order thinking, and using CFQs—and the use of the *online thinking tools.* Teachers primarily used Visual Ranking with their students. A few used Showing Evidence or Seeing Reason, sometimes alone and sometimes along with Visual Ranking. In addition, teachers paid attention to the developmental levels of their students and adjusted tool use and higher-order thinking concepts accordingly.

At the same time, evidence points to areas in which teachers need more support, in both tool use and the pedagogical arena. Most teachers used only the most basic tool features, and few units incorporated multiple rounds of evidence collection and subsequent artifact revision. For

example, few teachers used the Teacher Comment feature to give feedback to students. In addition, teachers were by and large unable to discuss the specifics of the higher-order thinking skills they were attempting to get students to use, and they rarely assessed those skills. Students were unlikely to be asked to present and evaluate evidence in terms of its accuracy and persuasiveness. Moreover, specific features and functions of the online thinking tools were not used to support the activities that students did do.

Pea's (2004) distinction between *technological* and *social scaffolding* is useful for understanding these results. The Workshop familiarized these teachers with enough of the technological and social scaffolding necessary to implement the units they created in the Workshop and even, in some cases, to design new activities. Both teachers and students found the online thinking tools easy to use. However, teachers did not avail themselves of the full range of technological scaffolding in the tools, including such features as the ability to provide teacher comments and for students to save work and revisit it over time, as their knowledge and thinking about the topic deepens and as they collect new evidence to support or modify their ideas. In addition, although teachers were familiar with the pedagogical concepts that were the foundation of the social scaffolding necessary for tool use and unit implementation, an abstract understanding of the concepts did not necessarily lead to their application in the classroom.

Two other critical aspects of scaffolding are that it should be *developmentally appropriate* (Pea, 2004)—that is, it should take into consideration that learners are at different developmental levels and will have drastically different needs—and that it takes into account the special nature of subject matter knowledge that teachers need in order to teach students, which is also known as *pedagogical content knowledge* (Shulman, 1986; Wilson, Shulman, & Richert, 1987). The teachers in this study made connections to the developmental levels of their students and to the subject areas in which they were implementing the units. These teachers were able to adapt what they learned in the Workshop to fit their students. Other teachers may have a harder time doing so, which may help to explain why follow-up to the Workshop, in terms of Participant Teacher trainings and subsequent classroom implementation, has been less than optimal.

Scaffolding 21st century skills, chief among them higher-order thinking skills, poses a unique challenge for teachers. For most teachers in this study, applying these skills to classroom practice was problematic. While teachers felt like they learned and understood higher-order thinking skills during the Workshop—and were excited about them—for the most part teachers were unable to articulate the specific higher-order thinking skills they were targeting in the classroom. Understanding the abstract taxonomies and translating them into practical and operationalized activities relevant to subject areas and students' ages are two different things. It may be that teachers were doing this in the classroom but were unable to articulate it in interviews or represent it in artifacts, such as activity logs or unit plans. An alternate explanation is that learning these new skills and concepts involves a developmental process for teachers that occurs over time, as they grapple with different ways of teaching and learning. Teachers may need experience in seeing and discovering how they can support critical thinking with their students and integrate it into their units while also using technology.

Moving beyond individual teachers' units and classrooms provides additional insight into why and how these teachers successfully implemented units. Two of the sites in particular illustrate the importance of *fertile ground*—i.e., the school and district contexts in which the Workshop concepts and tools were able to take root. In these sites, teachers had a deeper engagement with the Workshop's content; there existed a community of practice that valued not only technology integration but also striving for the integration of higher-order thinking skills into the curriculum. Resources and structures were in place that supported teachers in their efforts. In addition, teachers may have come to the Workshop with more background knowledge and a stronger pedagogical foundation, not only because of their individual characteristics but also because the Workshop was aligned with existing school or district initiatives; these teachers had prior engagement with the Workshop's concepts. Research has shown that successful professional development is ongoing while teachers try out new techniques and strategies. These contexts provided environments that made available, by their very nature, some measure of follow-up to the Workshop.

Finally, a word about *critical thinking.* At the heart of the Workshop is a desire to help teachers and students use higher levels of critical thinking in the classroom. Across the years there have

been many appeals for teachers to integrate critical and higher-order thinking skills into the curriculum (Eisner, 1964; Ennis, 2001). But however widespread the consensus on the importance of critical thinking in education, there is little accord about what constitutes critical thinking or how educators perceive it. The term "critical thinking" has been continually developed in the literature (Baroody & Ginsburg, 1990; Costa, 2001; Ennis, 2001; Fisher & Scriven, 1997); however, little research has been done on how teachers are actually adapting these theories into practice during teaching, especially looking across all grades, subject areas, and levels of student ability. As found in this study, it is difficult to understand how teachers are adapting learning taxonomies and cognitive models of critical thinking in the classroom without a full investigation into this specific area.

Despite any shortcomings identified in the literature, Cotton (1991) found many overall benefits to learners in a review of the research on teaching thinking skills. Therefore, finding ways to help teachers focus on higher-order thinking skills may still greatly help students, and more research is needed to support this process. Thus, more recent calls for incorporating critical thinking into K–12 education go a step further, combining this understanding with ICT (International Committee on ICT Literacy, 2002; Partnership for 21st Century Skills, 2003). Research involving how to promote higher-order thinking skills in children of all ages is currently in demand and greatly needed. Intel's work in analyzing how critical thinking is understood and used by teachers in the classroom is an important beginning in fulfilling this call for researching higher-order thinking, especially considering the increasing demand to incorporate technology into the classroom.

CONCLUSION

This research effort has uncovered findings on how teachers implement the pedagogical concepts of the Workshop and the online thinking tools, how these two facets of the training interact, and what may influence this process. This study investigated how Master and Participant Teachers followed up on the Workshop training and implemented the units created during the training or ensuing units. Thus, it offers a glimpse into potential "highlights" and "lowlights" when teachers attempt to turn what they learned in the Workshop into classroom practice.

In addition, the study offers a baseline for classroom implementation, useful for seeing if positive trends continue and if the latest version of the manual alleviates some of the challenges described here. Version 2.0 of the manual places an increased emphasis on unit creation as a more integrated part of the Workshop, which alone may increase the cohesiveness and effectiveness of how teachers learn to use the pedagogical concepts and the thinking tools together in the classroom. Version 2.0 also seeks to increase support for the incorporation of assessment throughout the units. This will not only directly impact teacher feedback and assessment during and after the unit, it may affect how teachers initially create and plan their units.

Overall, teachers were able to incorporate the concepts and tools from the Workshop appropriately into their classrooms, spanning a wide range of ages and subjects. This study revealed that while teachers may be strong in some areas of implementing the Workshop's pedagogical concepts and thinking tools, there are also areas of critical need. Addressing these needs within the training may be part of the solution, but more supports outside the training may also be needed. It is important to note that teachers who came from and returned to contexts that provided fertile ground had more successful unit implementations. The resources available in these contexts can be leveraged to support teachers after the Workshop training ends.

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APPENDICES

Appendix A: Site Recruitment

Appendix B: Data Collection Methods

Appendix C: Activity Log

Appendix D: Data Analysis Methods

Appendix E: Student Work Samples (Tool Use)

Appendix F: Student Work Samples (End Products)

APPENDIX A: SITE RECRUITMENT

To recruit potential sites, EDC/CCT began by establishing criteria for participation in the study. We sought out districts that met three key criteria:

- At least five teachers in district were interested and willing to participate in the evaluation study.
- Teachers taught grade 4 or above, in the content areas of English/language arts, science, or social studies.
- Teachers planned to implement a unit that used one or more of the online thinking tools during the study period (April–May, 2006).

Once the criteria were established, we reviewed completed Participant Teacher trainings as reported on Intel's extranet system. We then contacted Regional Training Agency coordinators, Senior Trainers, Master Teachers, and other local education agency contacts in areas we identified as promising, as well as staff from districts that had participated in the 2005 evaluation (15 regions and districts). In order to reach additional districts, we e-mailed MTs who had given permission to be contacted on the Workshop Follow-Up survey in November 2005. We conducted phone conferences with all districts interested in participating, and revised the criteria to include teachers in grades Pre-K–12 in all subject areas. This approach yielded six schools and districts. Because one school and one district were not ultimately able to secure the commitment of the minimum number of teachers, four districts agreed to participate in the study. One of those districts dropped out of the study in Week 1, because the teachers felt overburdened at the end of the school year (though this district expressed interest in participating in the fall of 2006). Data collection was launched in April 2006 in three districts and with 20 teachers. Six teachers ultimately dropped out during the study for personal reasons.

APPENDIX B: DATA COLLECTION METHODS

Activity Logs

Teachers filled out weekly activity logs for each week of their units that took place during this evaluation. The units varied in length, ranging from three to five weeks in duration. Thus, teachers only filled out logs for those weeks in which the unit and the evaluation overlapped.

The logs consisted of several aspects (see Appendix C). Teacher reported on how they grouped the students during the activities that took place that week. They also reported on which various student activities, teacher activities, thinking skills, assessment strategies, and resources were used or targeted that week.

Most importantly, teachers reported which tools they used during that week, if any. If they reported using one or more tools, they subsequently checked what tool features, student activities, and thinking skills involving that tool were used during the lesson(s).

Teachers gave a written description of what they did that week to help elaborate on the items they had checked. For each day of the week, teachers were instructed to describe the class's daily activities and any additional information they thought was important.

Interview I

During the second week of the evaluation period, researchers performed a phone interview with each teacher that lasted approximately 30 minutes. This took place early in the teachers' units, so the Workshop and teachers' prior knowledge were the main discussion topics.

Teachers were asked why they took the Workshop and what their biggest take-away from the training was. We discussed their prior knowledge of the project approach, CFQs, and promoting higher-order thinking skills. Interviewers also asked how the teachers had used these concepts before the Workshop and how their knowledge and classroom use of them had changed since the Workshop.

Preliminary discussions of how teachers were using the tools and how they thought the tools enhanced student learning also occurred in this interview.

Interview II and Site Visits

During the fourth and fifth week, evaluators visited the schools, where more lengthy interviews with teachers were conducted. This interview was late in the teachers' units, so the actual unit and use of the tools were the main discussion topics. The most helpful aspects of the training for both unit creation and unit implementation were also discussed. The unit plan and student examples and artifacts constituted the rest of the interview.

Teachers were asked how the unit went as a whole. Researchers discussed which aspects of the plan were particularly beneficial or disappointing. Questions included how the teachers perceived the project approach, CFQs, and higher-order thinking skills, particularly in relation to their unit and their class. How each of these played out in the classroom during the course of the unit was also discussed.

Site visits gave researchers the chance to observe the school environment. Teachers often discussed the overall philosophies of the school, which programs they were running, the emphasis of their curriculum, and other aspects that provided a better context for our analysis.

During these visits, unit plans and student artifacts were also discussed. Teachers gave some of these artifacts to the evaluators to be further examined, as described below.

Artifact Review

Artifacts were used to guide the second interview and to triangulate teachers' statements about unit implementation and student work.

Before the site visit, researchers had teachers select examples of student work that would help facilitate discussion. Teachers were asked to select an example of student work that "did not meet expectations," one that "met expectations," and one that "exceeded expectations."

Researchers asked to see examples from the both the end product of the entire unit and students' products from the thinking tools.

Student "process" artifacts

Student products that generated directly from using the tools, such as maps from Seeing Reason, were deemed "process artifacts" and were used to discuss the unit. Teachers were asked to use their unit plans and student examples to demonstrate their expectations of the students and if the students accomplished what the teacher had hoped. Teachers also were asked how the tools promoted higher-order thinking skills and if they could elaborate by using the students' work as examples. Assessments of the tool use and process artifacts were also talked about during the second interview.

Student "product" artifacts

Student products generated as a cumulative unit project were deemed "product artifacts" and were also used to discuss the units. The product artifacts demonstrated the overall goals of the unit. Teachers discussed how these projects related to promotion of higher-order thinking as well as the project approach. The second interview focused on whether the overall goals of the unit were reached, such as students deepening their knowledge of the content area, and how the product artifacts reflected this.

Unit plans

Before researchers visited, they asked teachers to have their unit plans ready for discussion. Teachers and interviewers used this artifact to guide the interview and discuss which aspects of the units were and were not working as expected. Interviewers also received a copy of the unit plan to use for later analysis.

APPENDIX C: ACTIVITY LOG

Your Name:

A: THE WEEK IN REVIEW

Write a brief overview summarizing what the class did this week in relation to the project.

The guiding question and/or theme for this week's activities was:

Select which of the following you implemented in your class this week

Instructional Strategies and Classroom Activities: check *all* the activities that you used in relation to the project this week

GROUPING
- ☐ Individual
- ☐ Pairs /Small groups (2-4)
- ☐ Large groups (5-half class)
- ☐ Whole class
- ☐ Other:

QUESTIONING STRATEGIES
Please describe:

STUDENT ACTIVITIES
- ☐ Seat work/individual work
- ☐ Group work
- ☐ Brainstorming
- ☐ Role playing
- ☐ Read-alouds
- ☐ Have small group discussions
- ☐ Whole class discussion
- ☐ Hands on work/ work with manipulatives (incl. science labs)
- ☐ Library work
- ☐ Internet searches
- ☐ Writing tasks
- ☐ Readings
- ☐ Generating questions
- ☐ Presentations
- ☐ Debate
- ☐ Other (explain):

TEACHER ACTIVITIES
- ☐ Lecture
- ☐ Advise
- ☐ Facilitate class discussion
- ☐ Show a video
- ☐ Demonstrate/model activity for students
- ☐ Monitor/assess student understanding
- ☐ Monitor/assess student performance or skills
- ☐ Collaborate with students
- ☐ Collaborate with colleagues
- ☐ Other:

Thinking Skills: check *all* the thinking skills you specifically targeted this week
- ☐ Basic knowledge acquisition
- ☐ Recall
- ☐ Communication skills
- ☐ Problem solving
- ☐ Critical thinking
- ☐ Interpersonal and collaborative learning
- ☐ Self-directional/self-monitoring skills (intrapersonal)
- ☐ Analyze and evaluate data
- ☐ Other:

Assessment: check *all* the assessment strategies you used in relation to the project this week
- ☐ In-class assignments
- ☐ Classroom participation
- ☐ Student presentations
- ☐ Homework assignments
- ☐ Teacher-made quizzes and tests
- ☐ Assessments included in published curriculum and textbooks
- ☐ Diagnostic tests
- ☐ District simulations or mandated exams
- ☐ Authentic assessments (e.g. portfolios, experiments, read-alouds

Materials and Resources: check *all* the materials and resources you used in relation to the project this week
- ☐ Email
- ☐ Web resources
- ☐ Smartboard/projector
- ☐ Productivity tools (e.g., Word, PowerPoint, etc.)
- ☐ People outside classroom
- ☐ Print materials/textbooks
- ☐ Graphics or imaging software
- ☐ Specialized content-specific software
- ☐ Other:
- ☐ ONLINE THINKING TOOLS

- ☐ *Visual Ranking*
- ☐ *Seeing Reason*
- ☐ *Showing Evidence*

* IF YOU SELECTED ONE OR ALL OF THE ONLINE THINKING TOOLS, PLEASE CONTINUE ON THE NEXT PAGE.*

APPENDIX C: ACTIVITY LOG

Weekly Reflection

Did you notice anything interesting about student learning? Student interactions? What worked, and what didn't, in terms of questioning strategies, grouping, discussion, etc.? Is there anything else we should know about this week?

DAY	COMMENT
Mon, 4/10/06	
Tue, 4/11/06	
Wed, 4/12/06	
Thur, 4/13/06	
Fri, 4/14/06	

APPENDIX C: ACTIVITY LOG

B: DAILY USE OF ONLINE THINKING TOOLS

☐ VISUAL RANKING Minutes spent on tool use each day: M ☐ | T ☐ | W ☐ | Th ☐ | F ☐	☐ SEEING REASON Minutes spent on tool use each day: M ☐ | T ☐ | W ☐ | Th ☐ | F ☐	☐ SHOWING EVIDENCE Minutes spent on tool use each day: M ☐ | T ☐ | W ☐ | Th ☐ | F ☐
PROMPT/ASSIGNMENT	**PROMPT/ASSIGNMENT**	**PROMPT/ASSIGNMENT**
Student activities: check *all* the tool-related activities that students used this week		
☐Students created/added factors ☐Students created initial ranking ☐Students revised their rankings ☐Student discuss rankings in groups ☐Students presented their ranking to class ☐Other (explain):	☐Students created/entered variables ☐Students created a causal map ☐Students revised their maps ☐Student discuss maps in groups ☐Students presented maps to class ☐Other (explain):	☐Students developed hypotheses/or question ☐Students found/entered evidence ☐Students built their arguments ☐Students revised their arguments ☐Students discussed their arguments in groups ☐Students present their arguments to class ☐Students rated quality of evidence ☐Students organized evidence (used labels) ☐Students linked evidence to claim ☐Students rated claims ☐Other (explain):
Tool features: check *all* that students used this week		
☐Adding criteria ☐Correlation feature ☐Print ☐Create ranking ☐Student comments ☐Teacher comments ☐Teacher-created factors	☐Portfolio feature ☐Add new comment box ☐Print ☐Student comments ☐Teacher comments ☐Teacher-created variables	☐Simplified version ☐Full version ☐Print ☐Teacher creates evidence ☐Student comments ☐Teacher comments ☐Teacher-created hypothesis(es)/question(s)
Thinking Skills: check *all* the thinking skills you targeted this week, in relation to *tool use*		
☐Evaluate and prioritize information ☐View issue(s) from multiple perspectives ☐Make decisions by seeking consensus, negotiating new options ☐Collaborate with peers	☐Understand complex problems or systems that involve cause and effect ☐Discuss interpretations of problems/systems that involve cause and effect ☐Represent interpretations of problems/systems that involve cause and effect ☐Defend interpretations of problems/systems that involve cause and effect	☐Work on argumentation skills ☐Use strategies for encouraging discussion as students make claims, support claims with evidence, debate differences, reach conclusions ☐Analyze & evaluate criteria for their decisions

Did you encounter any technical problems when using the tools this week? ☐Yes | ☐No
If yes, please explain:

APPENDIX D: DATA ANALYSIS METHODS

This evaluation draws on results of a mixed-methods design, using both quantitative and qualitative data. Analysis of the weekly Activity Logs was performed exhaustively through quantitative measures. The frequency of each reported aspect of the logs was calculated across all six weeks of the study for each teacher. Each raw frequency was then translated into percentage of weeks present, since teachers' units were of different lengths (e.g., Teacher A reported targeting critical thinking three out of five weeks [60%] of her unit). Percentages were also calculated for how often each tool was used during each teacher's unit and how often there were weeks where no tools were used. This allowed us to look at the overriding emphases and practices of teachers across each week of their unit.

The Activity Log data was also broken into two sections: weeks where one or more tools were implemented and weeks where no tool was used. This allowed us to run analyses on weeks specifically targeting tool use and weeks where other learning was taking place. We were then able to compare these sections to see if there were differences in teachers' practicein weeks where the thinking tools were being used by students.

Both interviews were analyzed qualitatively, searching for trends in teachers' descriptions of all aspects of the unit, tools, teaching concepts, school environment, and Workshop. Researchers were able to use these in-depth interviews to gain an overall perspective as well as specific examples to begin to form the findings for this report.

Unit plans and student artifacts were used in a similar manner. These artifacts provided windows into teaching aspects, such as assessment and use of CFQs, that researchers may not have been able to gain from teacher descriptions alone. Students' process artifacts gave particular insight into tool use, whereas student product artifacts gave a better picture of the overall unit.

APPENDIX E: STUDENT WORK SAMPLES (TOOL USE)

Before our site visits, we asked teachers to select three examples of student work: an example that met the teacher's expectations, one that exceeded expectations, and one that did not meet expectations. We asked them to do this for the tool artifacts (examples seen here) and for any end products of the unit (examples seen in Appendix F).

Figures 3 – 5: Teacher 4 shared with us examples of student work using the Visual Ranking tool in her 6th grade mathematics unit about 3-D shapes.

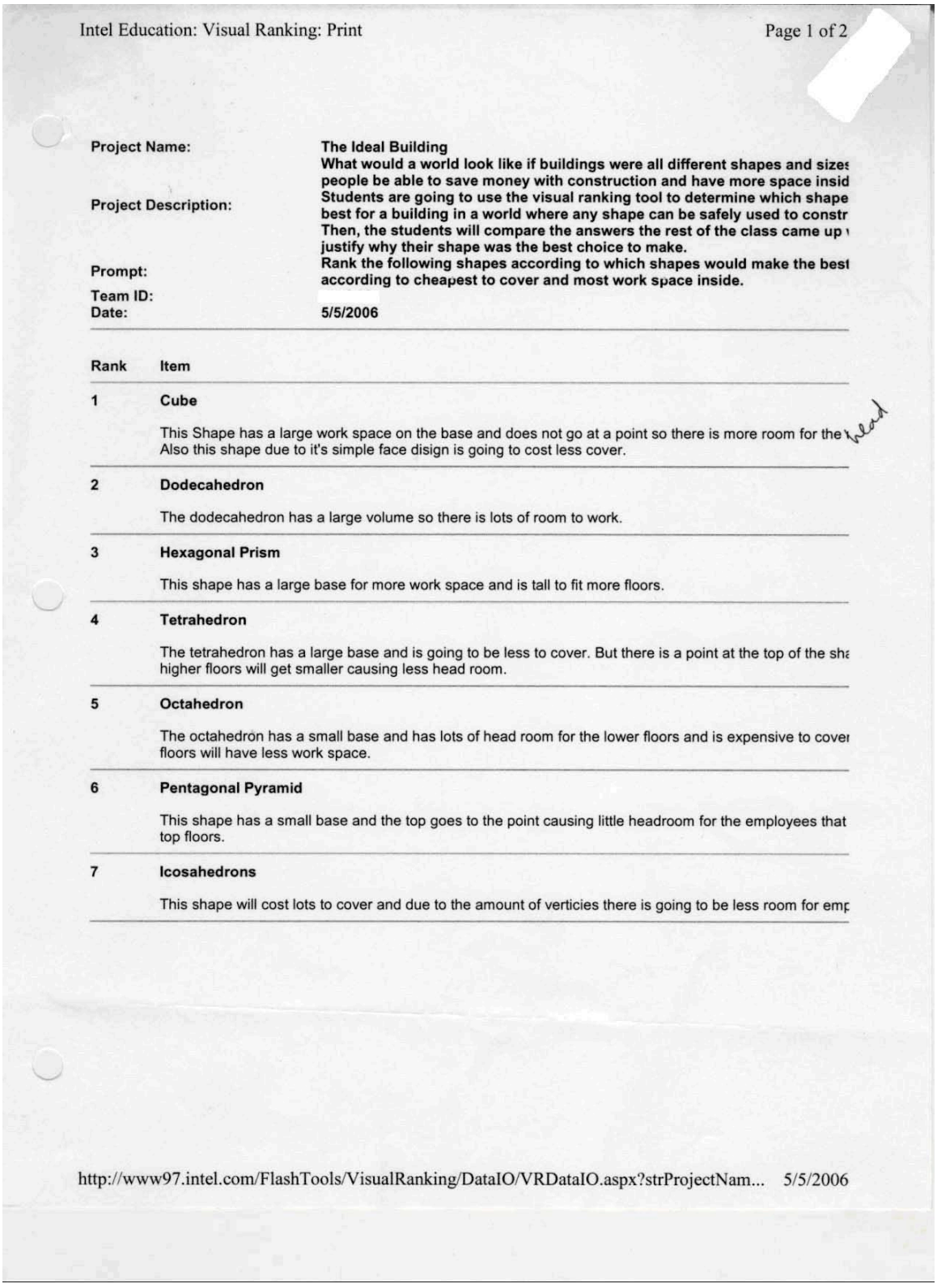
Figures 6 – 8: Teacher 2 shared with us examples of student work using the Visual Ranking tool in her 5th grade science unit about biomes.

Figures 9 – 11: Teacher 8 shared with us examples of student work using the Showing Evidence tool in her 4th grade literature unit about character traits.

Figures 12 – 14: Teacher 12 shared with us examples of student work using the Visual Ranking tool in her 4th grade literature unit about events in a story.

Figures 15 – 17: Teacher 3 shared with us examples of student work using the Seeing Reason tool in her 5th grade literature unit about character traits.

Figure 3. Teacher 4's example of student work that exceeded expectations.



Intel Education: Visual Ranking: Print Page 1 of 2

Project Name: The Ideal Building

Project Description: What would a world look like if buildings were all different shapes and sizes people be able to save money with construction and have more space insid Students are going to use the visual ranking tool to determine which shape best for a building in a world where any shape can be safely used to constr Then, the students will compare the answers the rest of the class came up justify why their shape was the best choice to make.

Prompt: Rank the following shapes according to which shapes would make the best according to cheapest to cover and most work space inside.

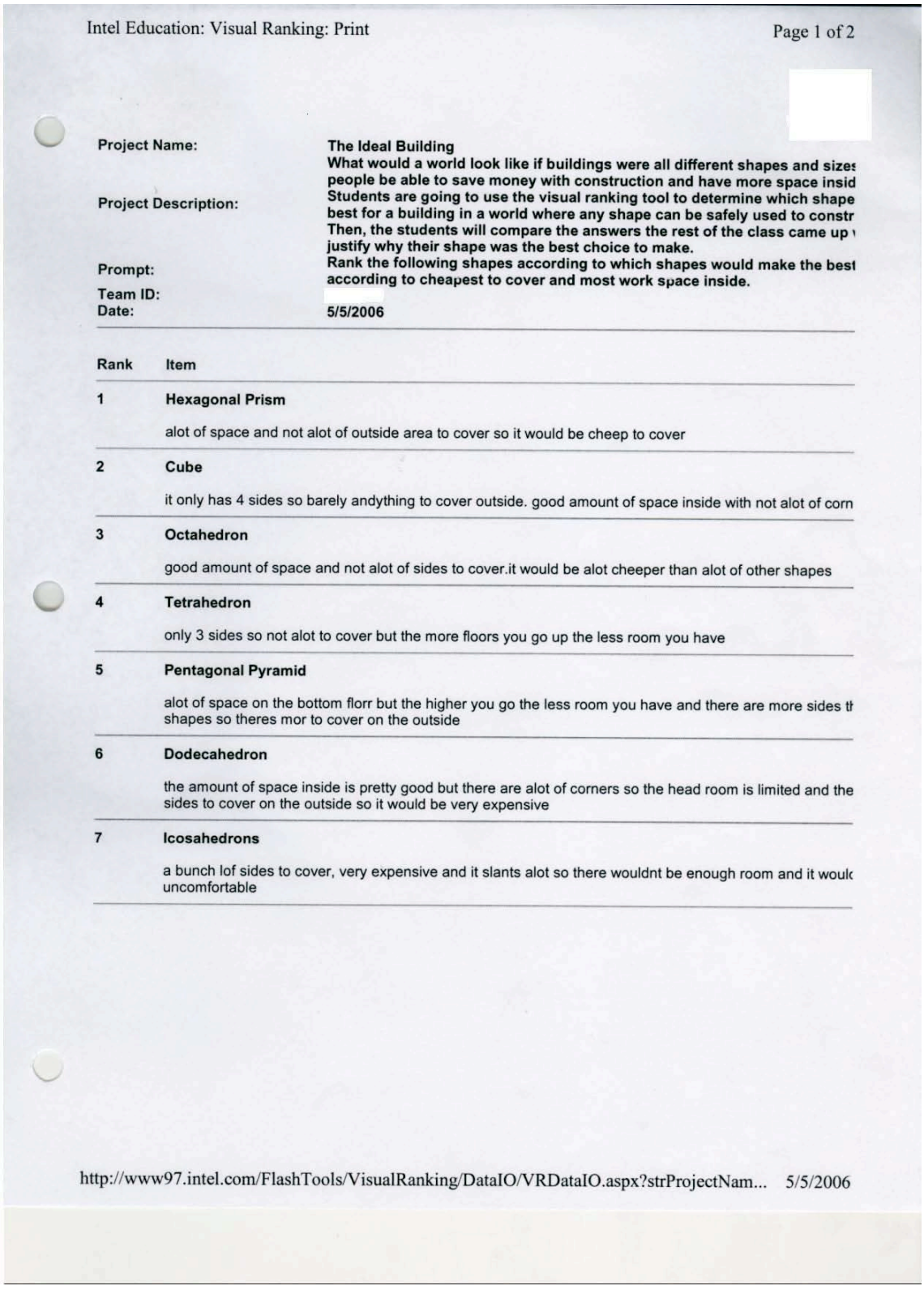
Team ID:

Date: 5/5/2006

Rank	Item	
1	**Cube**	
	This Shape has a large work space on the base and does not go at a point so there is more room for the head Also this shape due to it's simple face disign is going to cost less cover.	
2	**Dodecahedron**	
	The dodecahedron has a large volume so there is lots of room to work.	
3	**Hexagonal Prism**	
	This shape has a large base for more work space and is tall to fit more floors.	
4	**Tetrahedron**	
	The tetrahedron has a large base and is going to be less to cover. But there is a point at the top of the sha higher floors will get smaller causing less head room.	
5	**Octahedron**	
	The octahedron has a small base and has lots of head room for the lower floors and is expensive to cover floors will have less work space.	
6	**Pentagonal Pyramid**	
	This shape has a small base and the top goes to the point causing little headroom for the employees that top floors.	
7	**Icosahedrons**	
	This shape will cost lots to cover and due to the amount of verticies there is going to be less room for emp	

http://www97.intel.com/FlashTools/VisualRanking/DataIO/VRDataIO.aspx?strProjectNam... 5/5/2006

Figure 4. Teacher 4's example of student work that met expectations.



Intel Education: Visual Ranking: Print Page 1 of 2

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Prompt: Rank the following shapes according to which shapes would make the best according to cheapest to cover and most work space inside.

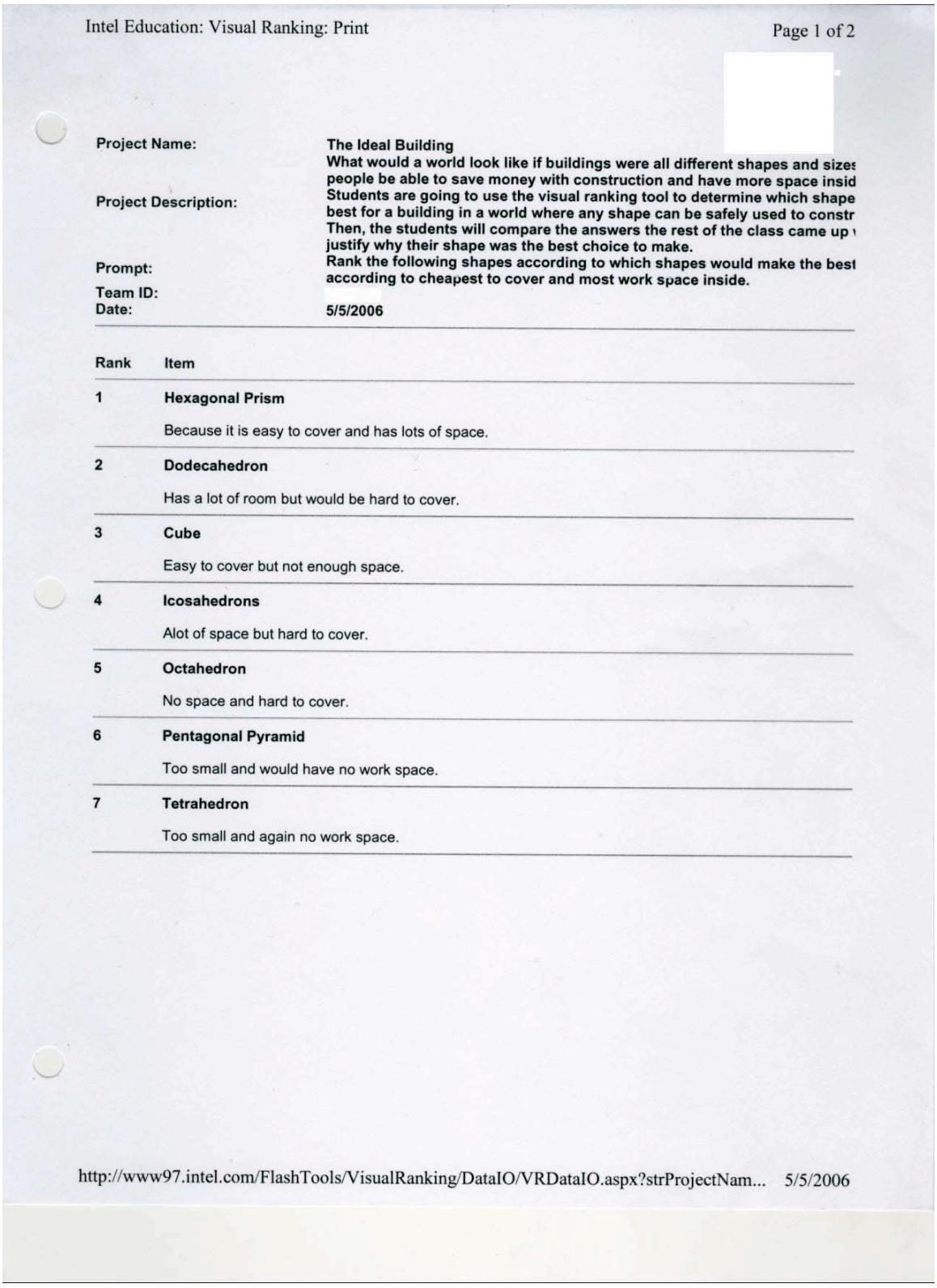
Team ID:

Date: 5/5/2006

Rank	Item	
1	**Hexagonal Prism**	alot of space and not alot of outside area to cover so it would be cheep to cover
2	**Cube**	it only has 4 sides so barely andything to cover outside. good amount of space inside with not alot of corn
3	**Octahedron**	good amount of space and not alot of sides to cover.it would be alot cheeper than alot of other shapes
4	**Tetrahedron**	only 3 sides so not alot to cover but the more floors you go up the less room you have
5	**Pentagonal Pyramid**	alot of space on the bottom florr but the higher you go the less room you have and there are more sides th shapes so theres mor to cover on the outside
6	**Dodecahedron**	the amount of space inside is pretty good but there are alot of corners so the head room is limited and the sides to cover on the outside so it would be very expensive
7	**Icosahedrons**	a bunch lof sides to cover, very expensive and it slants alot so there wouldnt be enough room and it would uncomfortable

http://www97.intel.com/FlashTools/VisualRanking/DataIO/VRDataIO.aspx?strProjectNam... 5/5/2006

Figure 5. Teacher 4's example of student work that did not meet expectations.



Intel Education: Visual Ranking: Print Page 1 of 2

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Prompt: Rank the following shapes according to which shapes would make the best according to cheapest to cover and most work space inside.

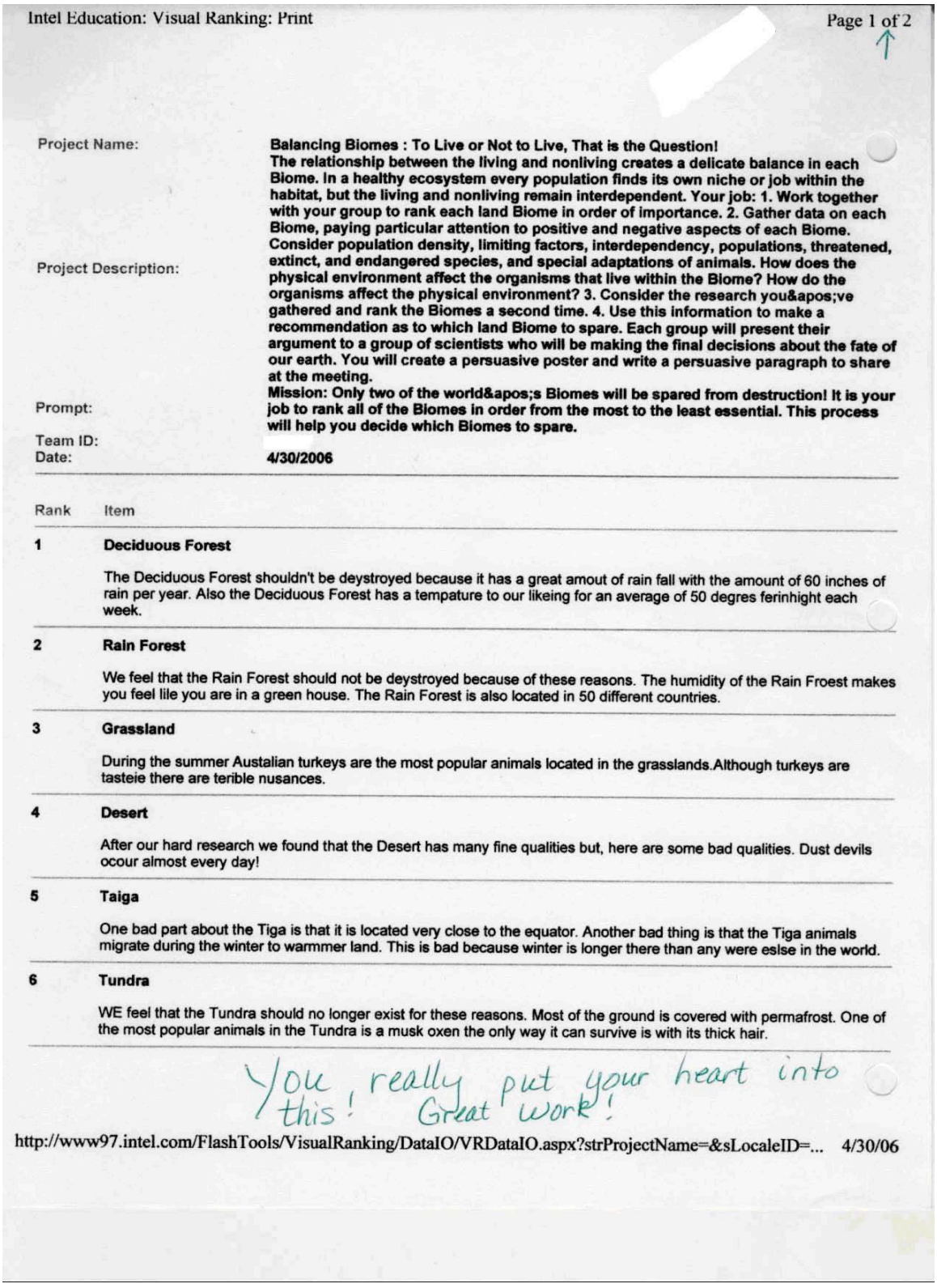
Team ID:

Date: 5/5/2006

Rank	Item
1	**Hexagonal Prism** Because it is easy to cover and has lots of space.
2	**Dodecahedron** Has a lot of room but would be hard to cover.
3	**Cube** Easy to cover but not enough space.
4	**Icosahedrons** Alot of space but hard to cover.
5	**Octahedron** No space and hard to cover.
6	**Pentagonal Pyramid** Too small and would have no work space.
7	**Tetrahedron** Too small and again no work space.

http://www97.intel.com/FlashTools/VisualRanking/DataIO/VRDataIO.aspx?strProjectNam... 5/5/2006

Figure 6. Teacher 2's example of student work that exceeded expectations.



Intel Education: Visual Ranking: Print

Page 1 of 2

Project Name: **Balancing Biomes : To Live or Not to Live, That is the Question!**

Project Description: **The relationship between the living and nonliving creates a delicate balance in each Biome. In a healthy ecosystem every population finds its own niche or job within the habitat, but the living and nonliving remain interdependent. Your job: 1. Work together with your group to rank each land Biome in order of importance. 2. Gather data on each Biome, paying particular attention to positive and negative aspects of each Biome. Consider population density, limiting factors, interdependency, populations, threatened, extinct, and endangered species, and special adaptations of animals. How does the physical environment affect the organisms that live within the Biome? How do the organisms affect the physical environment? 3. Consider the research you've gathered and rank the Biomes a second time. 4. Use this information to make a recommendation as to which land Biome to spare. Each group will present their argument to a group of scientists who will be making the final decisions about the fate of our earth. You will create a persuasive poster and write a persuasive paragraph to share at the meeting.**

Prompt: **Mission: Only two of the world's Biomes will be spared from destruction! It is your job to rank all of the Biomes in order from the most to the least essential. This process will help you decide which Biomes to spare.**

Team ID:

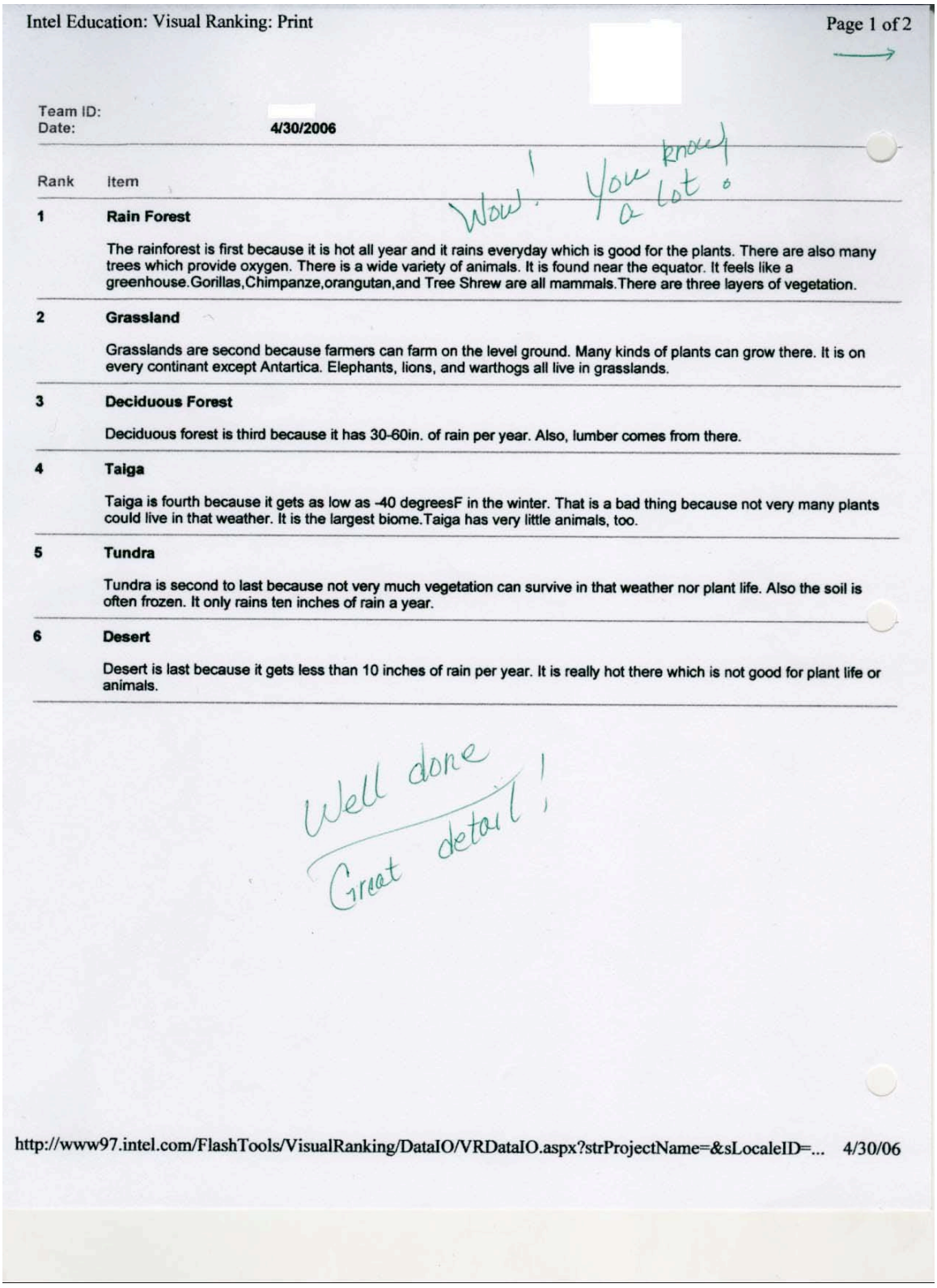
Date: **4/30/2006**

Rank	Item
1	**Deciduous Forest** The Deciduous Forest shouldn't be deystroyed because it has a great amout of rain fall with the amount of 60 inches of rain per year. Also the Deciduous Forest has a tempature to our likeing for an average of 50 degres ferinhight each week.
2	**Rain Forest** We feel that the Rain Forest should not be deystroyed because of these reasons. The humidity of the Rain Froest makes you feel lile you are in a green house. The Rain Forest is also located in 50 different countries.
3	**Grassland** During the summer Austalian turkeys are the most popular animals located in the grasslands.Although turkeys are tasteie there are terible nusances.
4	**Desert** After our hard research we found that the Desert has many fine qualities but, here are some bad qualities. Dust devils ocour almost every day!
5	**Taiga** One bad part about the Tiga is that it is located very close to the equator. Another bad thing is that the Tiga animals migrate during the winter to warmmer land. This is bad because winter is longer there than any were eslse in the world.
6	**Tundra** WE feel that the Tundra should no longer exist for these reasons. Most of the ground is covered with permafrost. One of the most popular animals in the Tundra is a musk oxen the only way it can survive is with its thick hair.

You really put your heart into this! Great work!

http://www97.intel.com/FlashTools/VisualRanking/DataIO/VRDataIO.aspx?strProjectName=&sLocaleID=... 4/30/06

Figure 7. Teacher 2's example of student work that met expectations.



Intel Education: Visual Ranking: Print

Page 1 of 2

Team ID:
Date: 4/30/2006

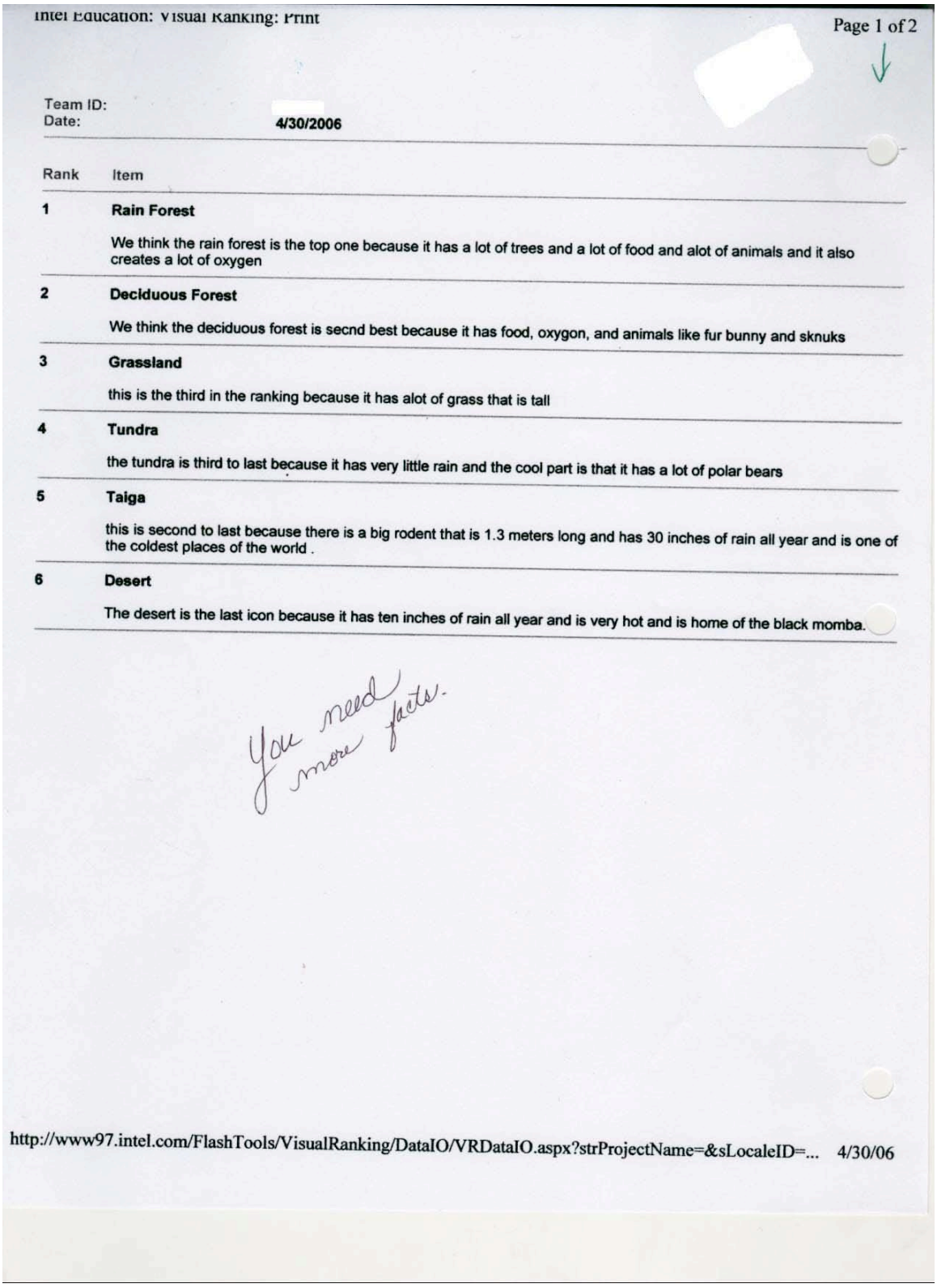
Wow! You know a lot.

Rank	Item
1	**Rain Forest** The rainforest is first because it is hot all year and it rains everyday which is good for the plants. There are also many trees which provide oxygen. There is a wide variety of animals. It is found near the equator. It feels like a greenhouse.Gorillas,Chimpanze,orangutan,and Tree Shrew are all mammals.There are three layers of vegetation.
2	**Grassland** Grasslands are second because farmers can farm on the level ground. Many kinds of plants can grow there. It is on every continant except Antartica. Elephants, lions, and warthogs all live in grasslands.
3	**Deciduous Forest** Deciduous forest is third because it has 30-60in. of rain per year. Also, lumber comes from there.
4	**Taiga** Taiga is fourth because it gets as low as -40 degreesF in the winter. That is a bad thing because not very many plants could live in that weather. It is the largest biome.Taiga has very little animals, too.
5	**Tundra** Tundra is second to last because not very much vegetation can survive in that weather nor plant life. Also the soil is often frozen. It only rains ten inches of rain a year.
6	**Desert** Desert is last because it gets less than 10 inches of rain per year. It is really hot there which is not good for plant life or animals.

Well done
Great detail!

http://www97.intel.com/FlashTools/VisualRanking/DataIO/VRDataIO.aspx?strProjectName=&sLocaleID=... 4/30/06

Figure 8. Teacher 2's example of student work that did not meet expectations.



Intel Education: Visual Ranking: Print

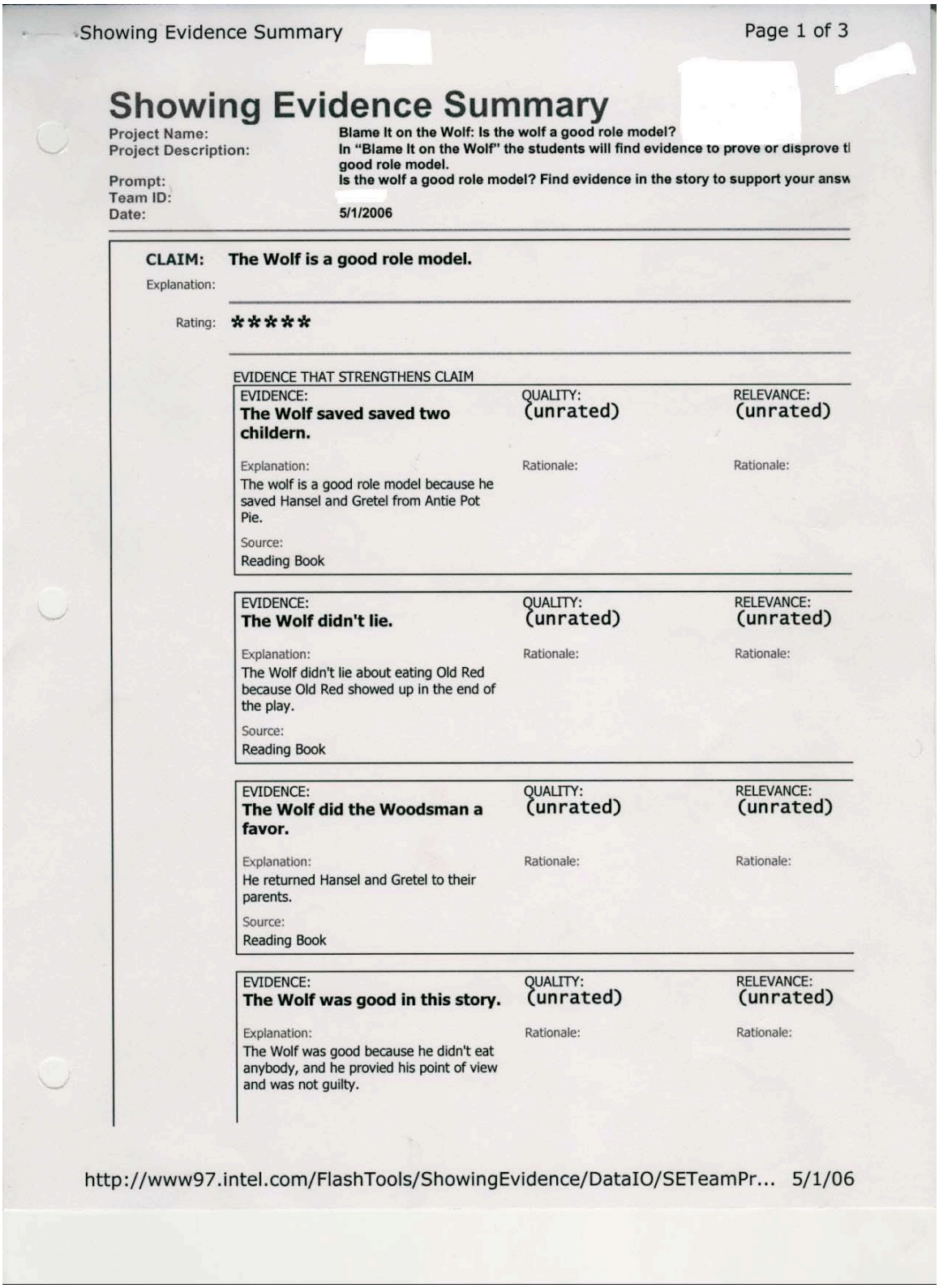
Team ID:
Date: 4/30/2006

Rank	Item
1	**Rain Forest** We think the rain forest is the top one because it has a lot of trees and a lot of food and alot of animals and it also creates a lot of oxygen
2	**Deciduous Forest** We think the deciduous forest is secnd best because it has food, oxygon, and animals like fur bunny and sknuks
3	**Grassland** this is the third in the ranking because it has alot of grass that is tall
4	**Tundra** the tundra is third to last because it has very little rain and the cool part is that it has a lot of polar bears
5	**Taiga** this is second to last because there is a big rodent that is 1.3 meters long and has 30 inches of rain all year and is one of the coldest places of the world .
6	**Desert** The desert is the last icon because it has ten inches of rain all year and is very hot and is home of the black momba.

You need more facts.

http://www97.intel.com/FlashTools/VisualRanking/DataIO/VRDataIO.aspx?strProjectName=&sLocaleID=... 4/30/06

Figure 9. Teacher 8's example of student work that exceeded expectations.



Showing Evidence Summary Page 1 of 3

Showing Evidence Summary

Project Name: Blame It on the Wolf: Is the wolf a good role model?
Project Description: In "Blame It on the Wolf" the students will find evidence to prove or disprove tl good role model.
Prompt: Is the wolf a good role model? Find evidence in the story to support your answ
Team ID:
Date: 5/1/2006

CLAIM: **The Wolf is a good role model.**

Explanation:

Rating: *****

EVIDENCE THAT STRENGTHENS CLAIM

EVIDENCE:	QUALITY:	RELEVANCE:
The Wolf saved saved two childern.	(unrated)	(unrated)
Explanation: The wolf is a good role model because he saved Hansel and Gretel from Antie Pot Pie. Source: Reading Book	Rationale:	Rationale:
EVIDENCE: **The Wolf didn't lie.**	**QUALITY:** (unrated)	**RELEVANCE:** (unrated)
Explanation: The Wolf didn't lie about eating Old Red because Old Red showed up in the end of the play. Source: Reading Book	Rationale:	Rationale:
EVIDENCE: **The Wolf did the Woodsman a favor.**	**QUALITY:** (unrated)	**RELEVANCE:** (unrated)
Explanation: He returned Hansel and Gretel to their parents. Source: Reading Book	Rationale:	Rationale:
EVIDENCE: **The Wolf was good in this story.**	**QUALITY:** (unrated)	**RELEVANCE:** (unrated)
Explanation: The Wolf was good because he didn't eat anybody, and he provied his point of view and was not guilty.	Rationale:	Rationale:

http://www97.intel.com/FlashTools/ShowingEvidence/DataIO/SETeamPr... 5/1/06

Figure 9 continued

Source:
Reading Book

EVIDENCE THAT WEAKENS CLAIM

EVIDENCE:	QUALITY:	RELEVANCE:
The Wolf didn't listen.	(unrated)	(unrated)
Explanation: The Wolf didn't listen when Juge had to reapeat herself three times.	Rationale:	Rationale:
Source: Reading Book		

EVIDENCE:	QUALITY:	RELEVANCE:
The Wolf was mean to the Three Little Pigs.	(unrated)	(unrated)
Explanation: The Wolf said I will huff and I will puff and I will blow your house into another galaxy, and I will make you my supper.	Rationale:	Rationale:
Source: Reading Book		

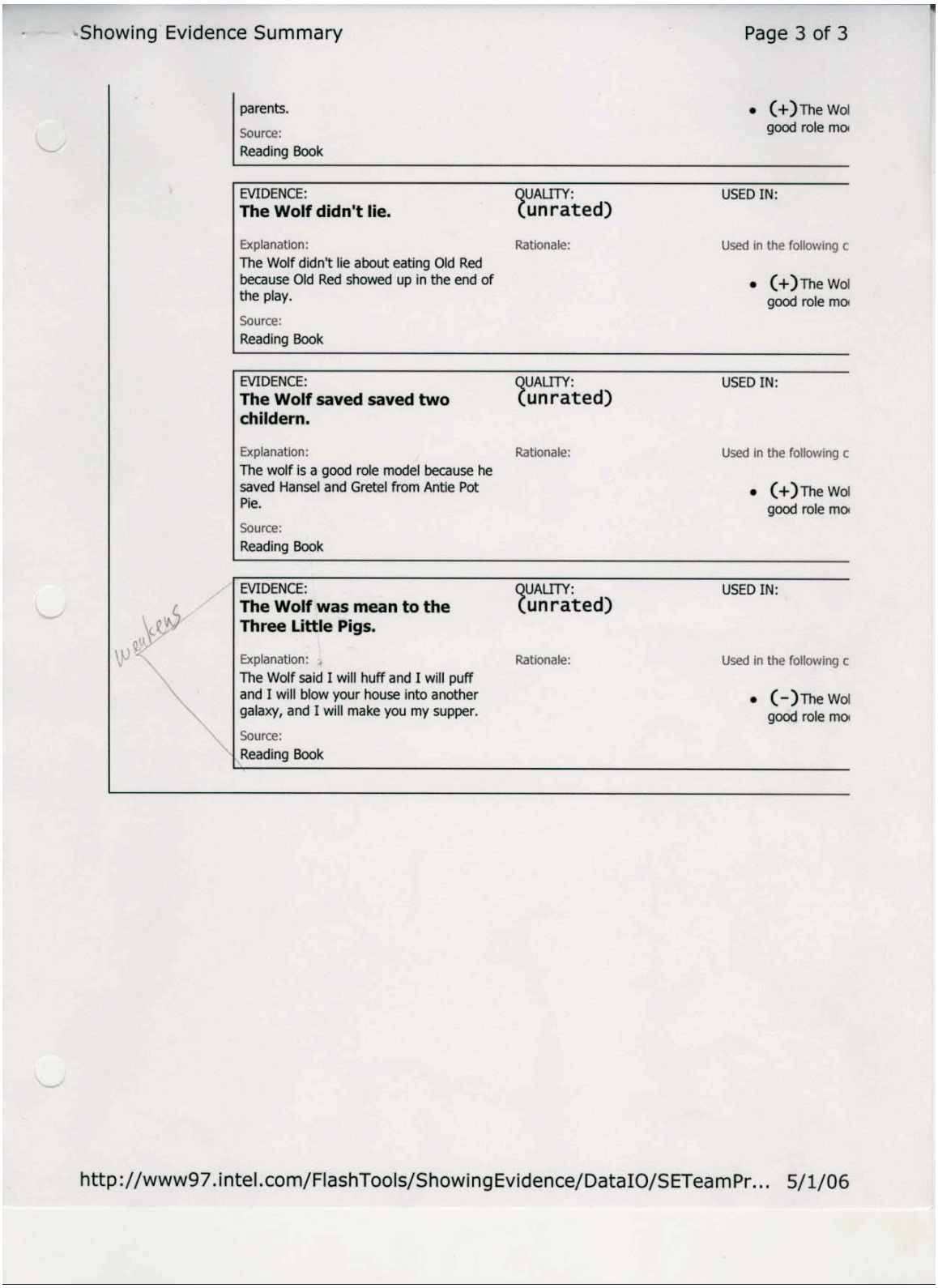
EVIDENCE BIN

EVIDENCE:	QUALITY:	USED IN:
The Wolf was good in this story.	(unrated)	
Explanation: The Wolf was good because he didn't eat anybody, and he provied his point of view and was not guilty.	Rationale:	Used in the following c • (+) The Wol good role mo
Source: Reading Book		

EVIDENCE:	QUALITY:	USED IN:
The Wolf didn't listen.	(unrated)	
Explanation: The Wolf didn't listen when Juge had to reapeat herself three times.	Rationale:	Used in the following c • (-) The Wol good role mo
Source: Reading Book		

EVIDENCE:	QUALITY:	USED IN:
The Wolf did the Woodsman a favor.	(unrated)	
Explanation: He returned Hansel and Gretel to their	Rationale:	Used in the following c

Figure 9 continued



Showing Evidence Summary

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parents.

Source:
Reading Book

- (+) The Wol good role mo

EVIDENCE:	QUALITY:	USED IN:
The Wolf didn't lie.	(unrated)	
Explanation: The Wolf didn't lie about eating Old Red because Old Red showed up in the end of the play.	Rationale:	Used in the following c
Source: Reading Book		• (+) The Wol good role mo

EVIDENCE:	QUALITY:	USED IN:
The Wolf saved saved two childern.	(unrated)	
Explanation: The wolf is a good role model because he saved Hansel and Gretel from Antie Pot Pie.	Rationale:	Used in the following c
Source: Reading Book		• (+) The Wol good role mo

EVIDENCE:	QUALITY:	USED IN:
The Wolf was mean to the Three Little Pigs.	(unrated)	
Explanation: The Wolf said I will huff and I will puff and I will blow your house into another galaxy, and I will make you my supper.	Rationale:	Used in the following c
Source: Reading Book		• (-) The Wol good role mo

weakens

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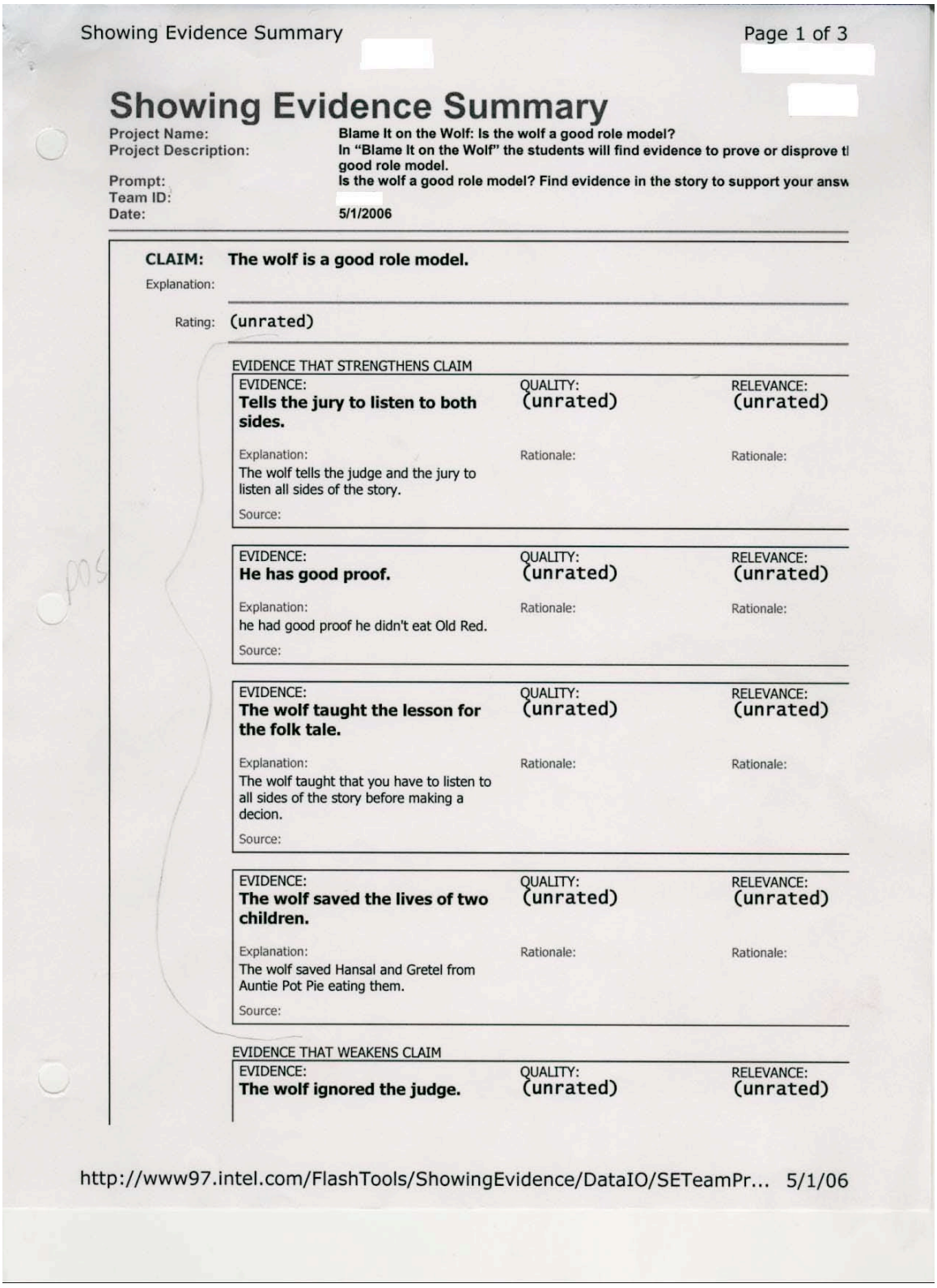
Figure 10. Teacher 8's example of student work that met expectations.



Showing Evidence Summary Page 1 of 3

Showing Evidence Summary

Project Name: Blame It on the Wolf: Is the wolf a good role model?
Project Description: In "Blame It on the Wolf" the students will find evidence to prove or disprove t good role model.
Prompt: Is the wolf a good role model? Find evidence in the story to support your answ
Team ID:
Date: 5/1/2006

CLAIM: **The wolf is a good role model.**

Explanation:

Rating: (unrated)

EVIDENCE THAT STRENGTHENS CLAIM

EVIDENCE:	QUALITY:	RELEVANCE:
Tells the jury to listen to both sides.	(unrated)	(unrated)
Explanation: The wolf tells the judge and the jury to listen all sides of the story.	Rationale:	Rationale:
Source:		

EVIDENCE:	QUALITY:	RELEVANCE:
He has good proof.	(unrated)	(unrated)
Explanation: he had good proof he didn't eat Old Red.	Rationale:	Rationale:
Source:		

EVIDENCE:	QUALITY:	RELEVANCE:
The wolf taught the lesson for the folk tale.	(unrated)	(unrated)
Explanation: The wolf taught that you have to listen to all sides of the story before making a decion.	Rationale:	Rationale:
Source:		

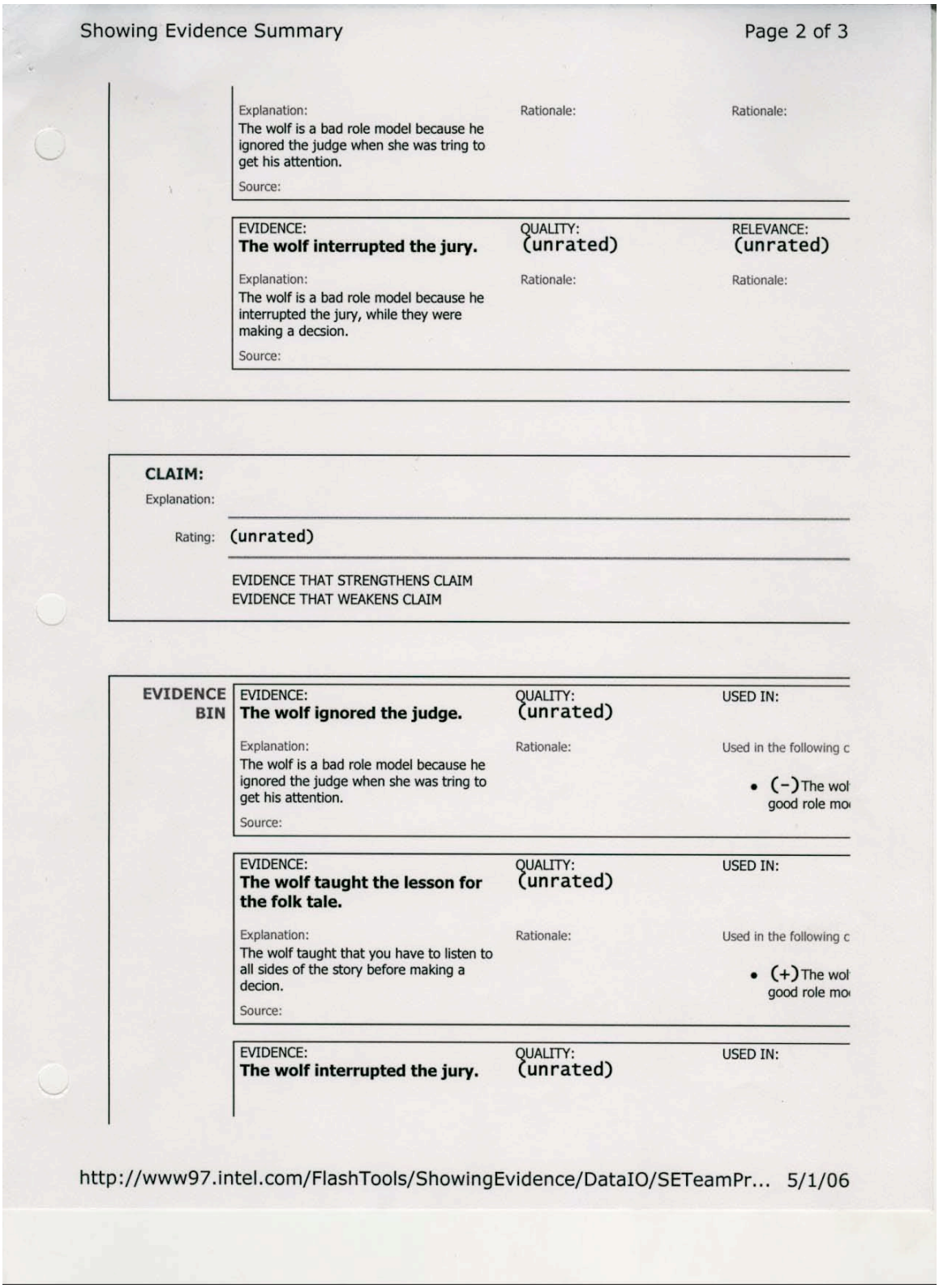
EVIDENCE:	QUALITY:	RELEVANCE:
The wolf saved the lives of two children.	(unrated)	(unrated)
Explanation: The wolf saved Hansal and Gretel from Auntie Pot Pie eating them.	Rationale:	Rationale:
Source:		

EVIDENCE THAT WEAKENS CLAIM

EVIDENCE:	QUALITY:	RELEVANCE:
The wolf ignored the judge.	(unrated)	(unrated)

http://www97.intel.com/FlashTools/ShowingEvidence/DataIO/SETeamPr... 5/1/06

Figure 10 continued



Showing Evidence Summary Page 2 of 3

Explanation: The wolf is a bad role model because he ignored the judge when she was tring to get his attention.
Source:
Rationale:
Rationale:

EVIDENCE: **The wolf interrupted the jury.**
QUALITY: (unrated)
RELEVANCE: (unrated)
Explanation: The wolf is a bad role model because he interrupted the jury, while they were making a decsion.
Source:
Rationale:
Rationale:

CLAIM:
Explanation:
Rating: (unrated)
EVIDENCE THAT STRENGTHENS CLAIM
EVIDENCE THAT WEAKENS CLAIM

EVIDENCE BIN

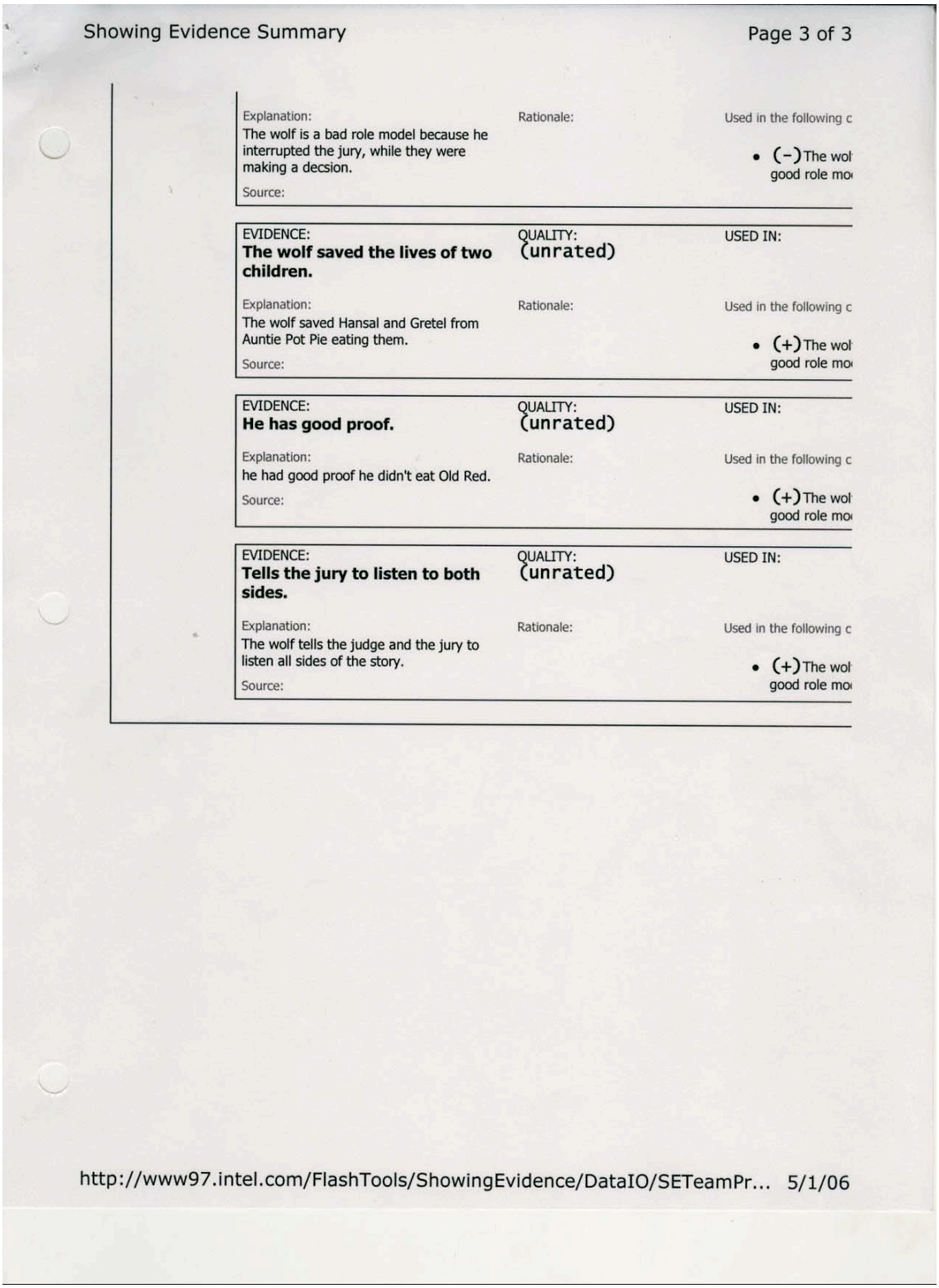
EVIDENCE: **The wolf ignored the judge.**
QUALITY: (unrated)
USED IN:
Explanation: The wolf is a bad role model because he ignored the judge when she was tring to get his attention.
Source:
Rationale:
Used in the following c
• (-) The wol good role mo

EVIDENCE: **The wolf taught the lesson for the folk tale.**
QUALITY: (unrated)
USED IN:
Explanation: The wolf taught that you have to listen to all sides of the story before making a decion.
Source:
Rationale:
Used in the following c
• (+) The wol good role mo

EVIDENCE: **The wolf interrupted the jury.**
QUALITY: (unrated)
USED IN:

http://www97.intel.com/FlashTools/ShowingEvidence/DataIO/SETeamPr... 5/1/06

Figure 10 continued



Showing Evidence Summary

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Explanation:
The wolf is a bad role model because he interrupted the jury, while they were making a decsion.

Source:

Rationale:

Used in the following c

- (-) The wol good role mo

EVIDENCE:
The wolf saved the lives of two children.

QUALITY:
(unrated)

USED IN:

Explanation:
The wolf saved Hansal and Gretel from Auntie Pot Pie eating them.

Source:

Rationale:

Used in the following c

- (+) The wol good role mo

EVIDENCE:
He has good proof.

QUALITY:
(unrated)

USED IN:

Explanation:
he had good proof he didn't eat Old Red.

Source:

Rationale:

Used in the following c

- (+) The wol good role mo

EVIDENCE:
Tells the jury to listen to both sides.

QUALITY:
(unrated)

USED IN:

Explanation:
The wolf tells the judge and the jury to listen all sides of the story.

Source:

Rationale:

Used in the following c

- (+) The wol good role mo

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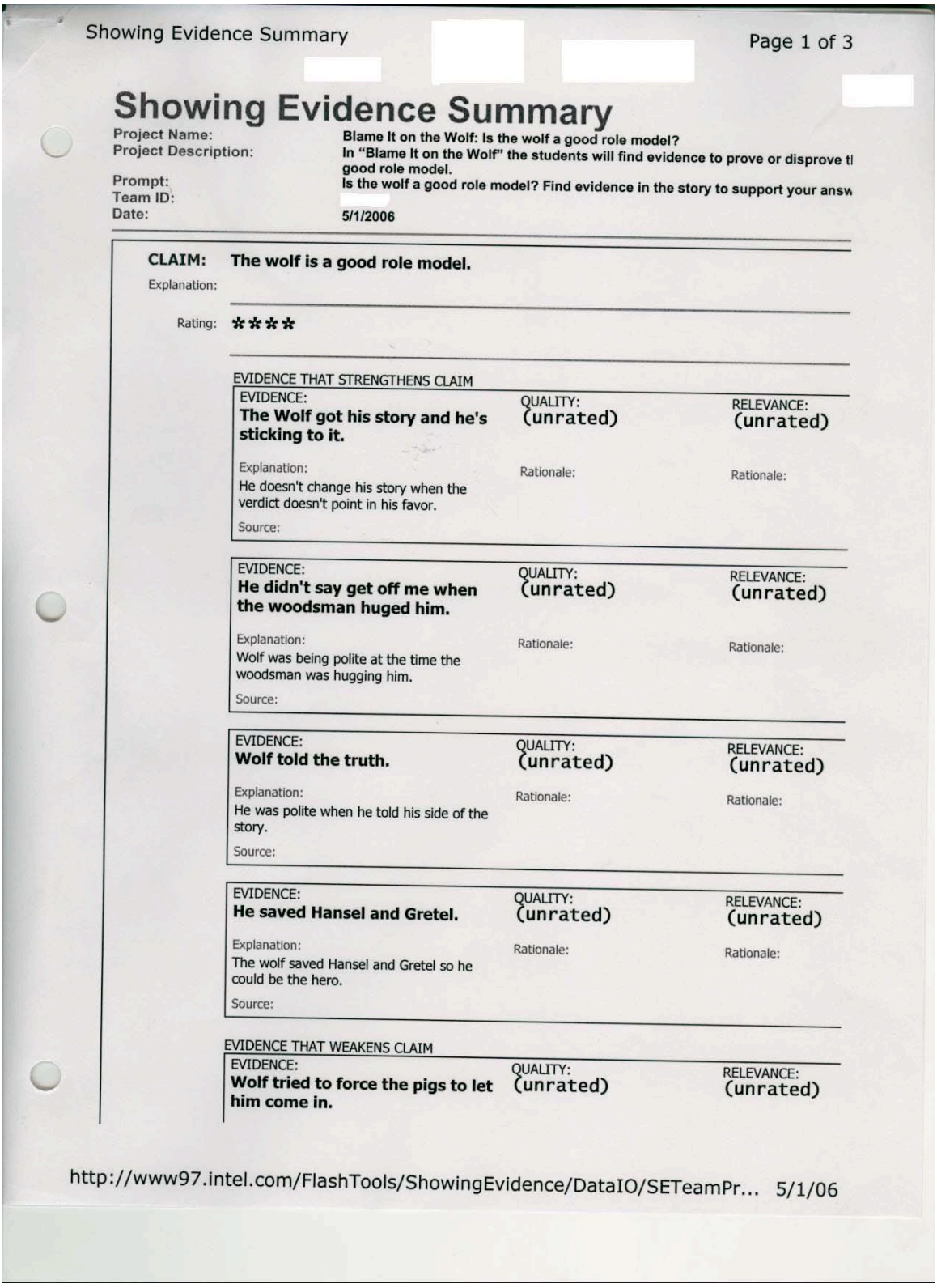
Figure 11. Teacher 8's example of student work that did not meet expectations.



Showing Evidence Summary Page 1 of 3

Showing Evidence Summary

Project Name: Blame It on the Wolf: Is the wolf a good role model?
Project Description: In "Blame It on the Wolf" the students will find evidence to prove or disprove tl good role model.
Prompt: Is the wolf a good role model? Find evidence in the story to support your answ
Team ID:
Date: 5/1/2006

CLAIM: **The wolf is a good role model.**

Explanation:

Rating: ****

EVIDENCE THAT STRENGTHENS CLAIM

EVIDENCE:	QUALITY:	RELEVANCE:
The Wolf got his story and he's sticking to it.	(unrated)	(unrated)
Explanation: He doesn't change his story when the verdict doesn't point in his favor.	Rationale:	Rationale:
Source:		

EVIDENCE:	QUALITY:	RELEVANCE:
He didn't say get off me when the woodsman huged him.	(unrated)	(unrated)
Explanation: Wolf was being polite at the time the woodsman was hugging him.	Rationale:	Rationale:
Source:		

EVIDENCE:	QUALITY:	RELEVANCE:
Wolf told the truth.	(unrated)	(unrated)
Explanation: He was polite when he told his side of the story.	Rationale:	Rationale:
Source:		

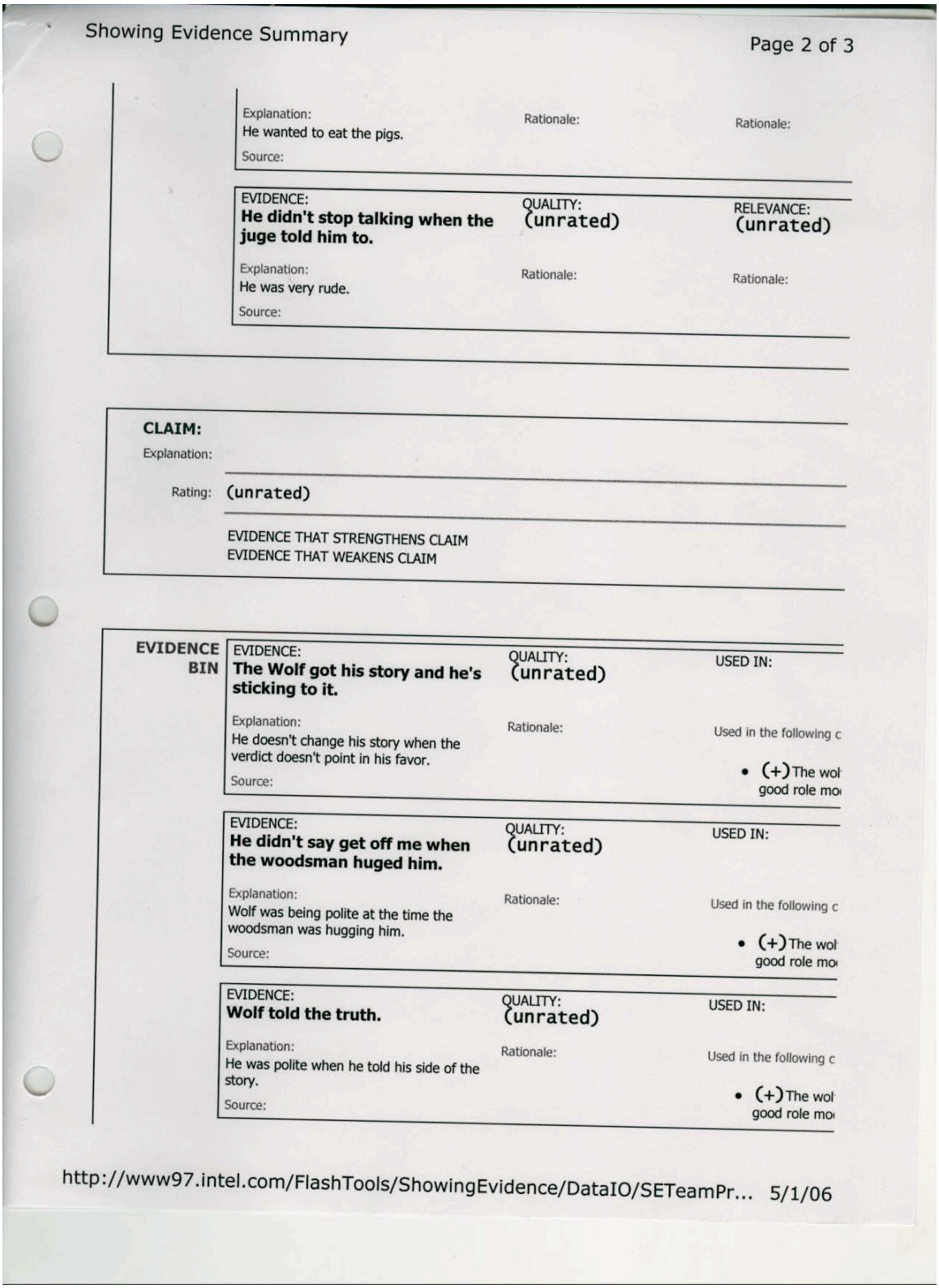
EVIDENCE:	QUALITY:	RELEVANCE:
He saved Hansel and Gretel.	(unrated)	(unrated)
Explanation: The wolf saved Hansel and Gretel so he could be the hero.	Rationale:	Rationale:
Source:		

EVIDENCE THAT WEAKENS CLAIM

EVIDENCE:	QUALITY:	RELEVANCE:
Wolf tried to force the pigs to let him come in.	(unrated)	(unrated)

http://www97.intel.com/FlashTools/ShowingEvidence/DataIO/SETeamPr... 5/1/06

Figure 11 continued



Showing Evidence Summary

Page 2 of 3

Explanation:
He wanted to eat the pigs.

Rationale:

Rationale:

Source:

EVIDENCE:
He didn't stop talking when the juge told him to.

QUALITY:
(unrated)

RELEVANCE:
(unrated)

Explanation:
He was very rude.

Rationale:

Rationale:

Source:

CLAIM:

Explanation:

Rating: (unrated)

EVIDENCE THAT STRENGTHENS CLAIM
EVIDENCE THAT WEAKENS CLAIM

EVIDENCE BIN

EVIDENCE:
The Wolf got his story and he's sticking to it.

QUALITY:
(unrated)

USED IN:

Explanation:
He doesn't change his story when the verdict doesn't point in his favor.

Rationale:

Used in the following c

- (+) The wol good role mo

Source:

EVIDENCE:
He didn't say get off me when the woodsman huged him.

QUALITY:
(unrated)

USED IN:

Explanation:
Wolf was being polite at the time the woodsman was hugging him.

Rationale:

Used in the following c

- (+) The wol good role mo

Source:

EVIDENCE:
Wolf told the truth.

QUALITY:
(unrated)

USED IN:

Explanation:
He was polite when he told his side of the story.

Rationale:

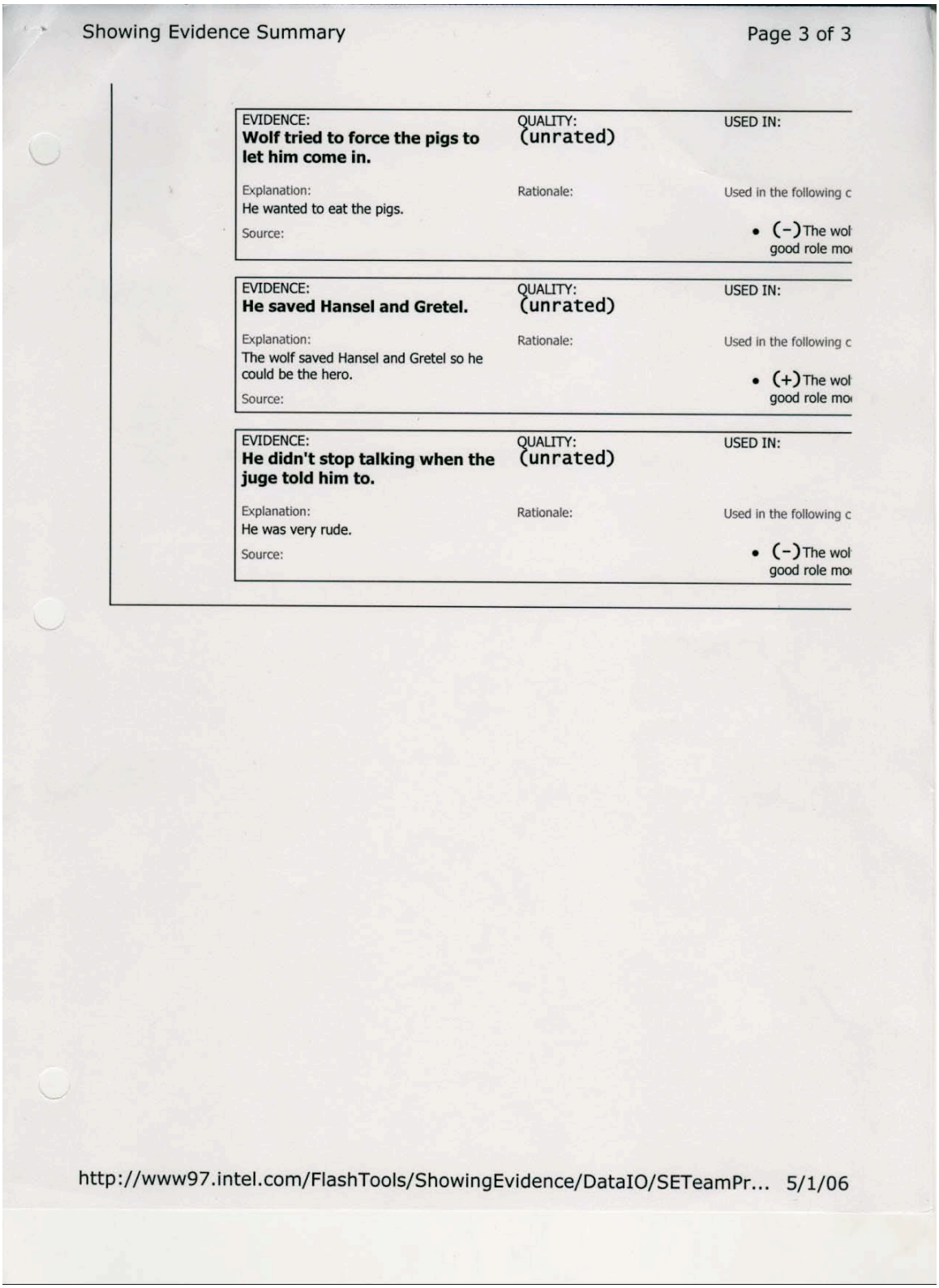
Used in the following c

- (+) The wol good role mo

Source:

http://www97.intel.com/FlashTools/ShowingEvidence/DataIO/SETeamPr... 5/1/06

Figure 11 continued



Showing Evidence Summary

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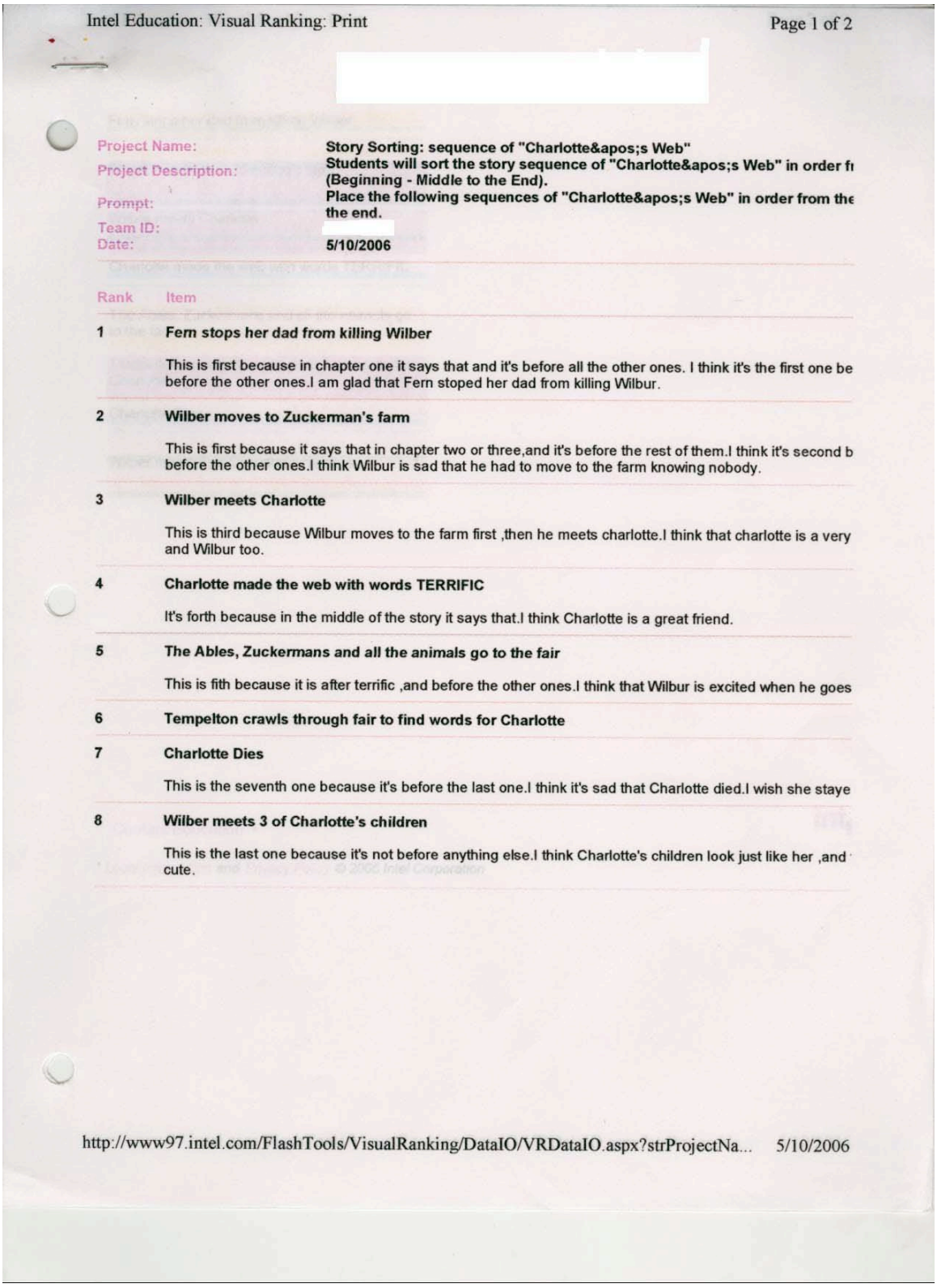
EVIDENCE:	QUALITY:	USED IN:
Wolf tried to force the pigs to let him come in.	(unrated)	
Explanation: He wanted to eat the pigs.	Rationale:	Used in the following c
Source:		• (-) The wol good role mo

EVIDENCE:	QUALITY:	USED IN:
He saved Hansel and Gretel.	(unrated)	
Explanation: The wolf saved Hansel and Gretel so he could be the hero.	Rationale:	Used in the following c
Source:		• (+) The wol good role mo

EVIDENCE:	QUALITY:	USED IN:
He didn't stop talking when the juge told him to.	(unrated)	
Explanation: He was very rude.	Rationale:	Used in the following c
Source:		• (-) The wol good role mo

http://www97.intel.com/FlashTools/ShowingEvidence/DataIO/SETeamPr... 5/1/06

Figure 12. Teacher 12's example of student work that exceeded expectations.



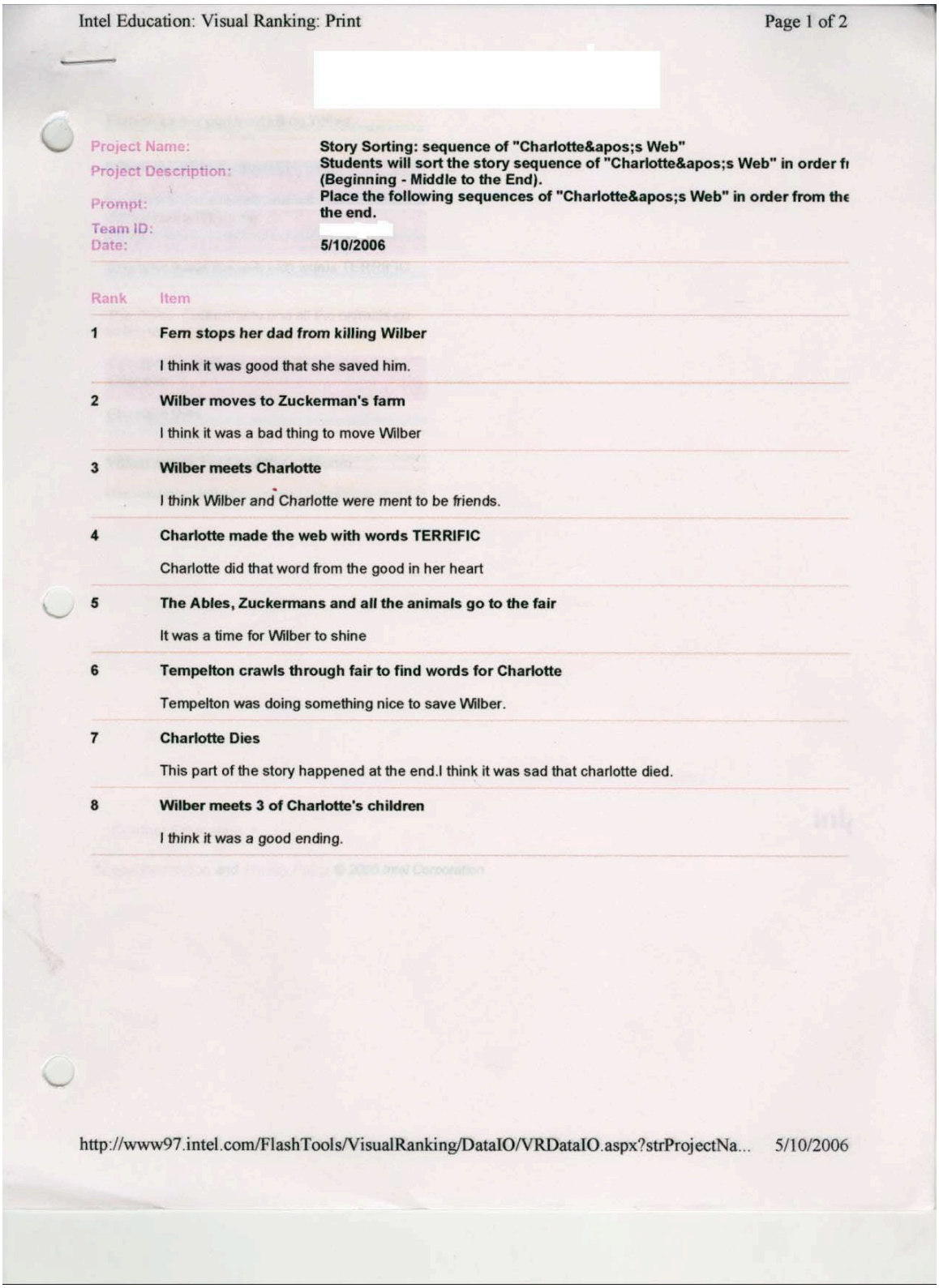
Intel Education: Visual Ranking: Print Page 1 of 2

Project Name: Story Sorting: sequence of "Charlotte's Web"
Project Description: Students will sort the story sequence of "Charlotte's Web" in order fi (Beginning - Middle to the End).
Prompt: Place the following sequences of "Charlotte's Web" in order from the the end.
Team ID:
Date: 5/10/2006

Rank	Item
1	**Fern stops her dad from killing Wilber** This is first because in chapter one it says that and it's before all the other ones. I think it's the first one be before the other ones.I am glad that Fern stoped her dad from killing Wilbur.
2	**Wilber moves to Zuckerman's farm** This is first because it says that in chapter two or three,and it's before the rest of them.I think it's second b before the other ones.I think Wilbur is sad that he had to move to the farm knowing nobody.
3	**Wilber meets Charlotte** This is third because Wilbur moves to the farm first ,then he meets charlotte.I think that charlotte is a very and Wilbur too.
4	**Charlotte made the web with words TERRIFIC** It's forth because in the middle of the story it says that.I think Charlotte is a great friend.
5	**The Ables, Zuckermans and all the animals go to the fair** This is fith because it is after terrific ,and before the other ones.I think that Wilbur is excited when he goes
6	**Tempelton crawls through fair to find words for Charlotte**
7	**Charlotte Dies** This is the seventh one because it's before the last one.I think it's sad that Charlotte died.I wish she staye
8	**Wilber meets 3 of Charlotte's children** This is the last one because it's not before anything else.I think Charlotte's children look just like her ,and cute.

http://www97.intel.com/FlashTools/VisualRanking/DataIO/VRDataIO.aspx?strProjectNa... 5/10/2006

Figure 13. Teacher 12's example of student work that met expectations.



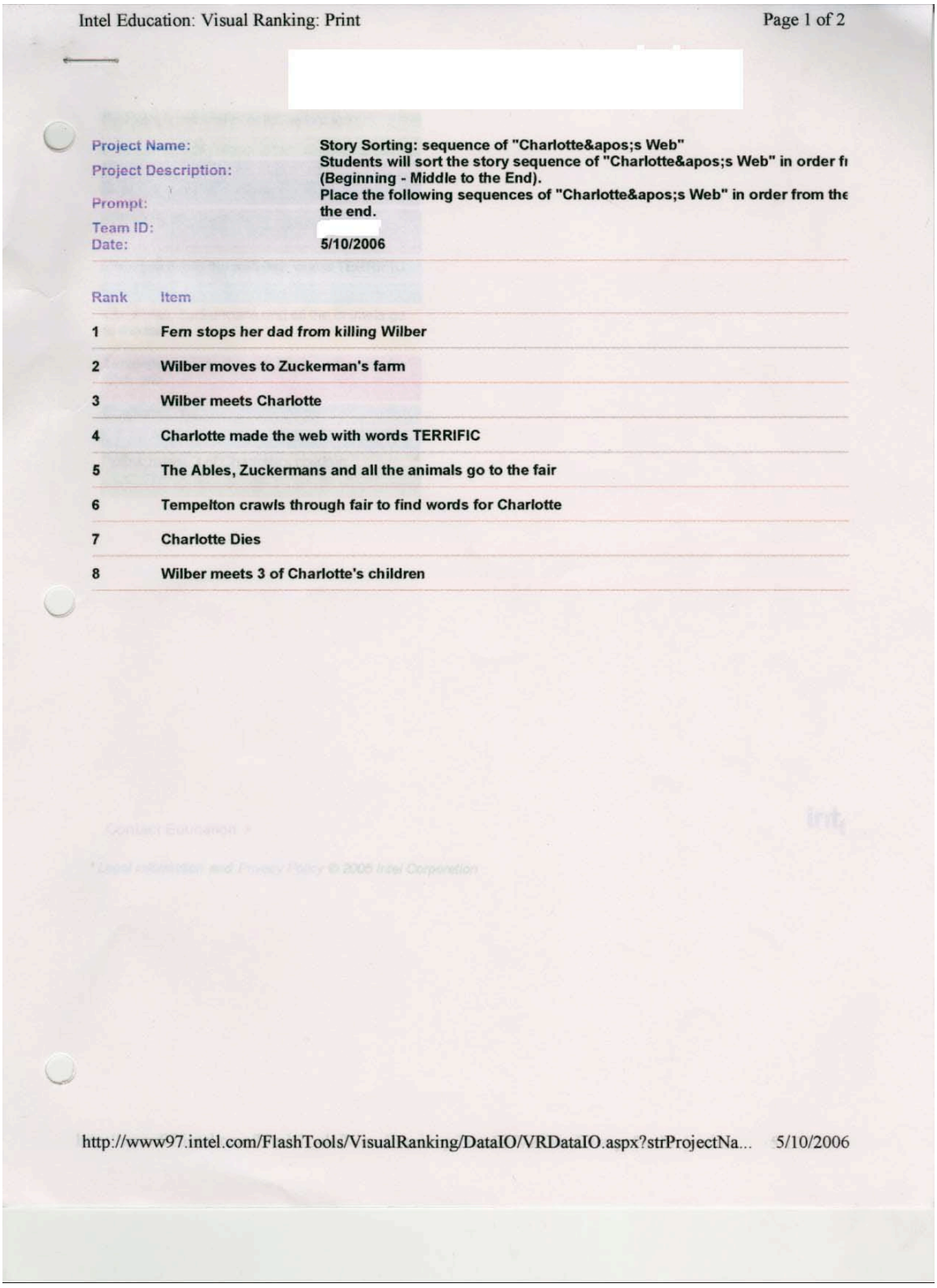
Intel Education: Visual Ranking: Print Page 1 of 2

Project Name: Story Sorting: sequence of "Charlotte's Web"
Project Description: Students will sort the story sequence of "Charlotte's Web" in order fr (Beginning - Middle to the End).
Prompt: Place the following sequences of "Charlotte's Web" in order from the the end.
Team ID:
Date: 5/10/2006

Rank	Item
1	**Fern stops her dad from killing Wilber** I think it was good that she saved him.
2	**Wilber moves to Zuckerman's farm** I think it was a bad thing to move Wilber
3	**Wilber meets Charlotte** I think Wilber and Charlotte were ment to be friends.
4	**Charlotte made the web with words TERRIFIC** Charlotte did that word from the good in her heart
5	**The Ables, Zuckermans and all the animals go to the fair** It was a time for Wilber to shine
6	**Tempelton crawls through fair to find words for Charlotte** Tempelton was doing something nice to save Wilber.
7	**Charlotte Dies** This part of the story happened at the end.I think it was sad that charlotte died.
8	**Wilber meets 3 of Charlotte's children** I think it was a good ending.

http://www97.intel.com/FlashTools/VisualRanking/DataIO/VRDataIO.aspx?strProjectNa... 5/10/2006

Figure 14. Teacher 12's example of student work that did not meet expectations.



Intel Education: Visual Ranking: Print Page 1 of 2

Project Name: Story Sorting: sequence of "Charlotte's Web"
Project Description: Students will sort the story sequence of "Charlotte's Web" in order fr
(Beginning - Middle to the End).
Prompt: Place the following sequences of "Charlotte's Web" in order from the
the end.
Team ID:
Date: 5/10/2006

Rank	Item
1	Fern stops her dad from killing Wilber
2	Wilber moves to Zuckerman's farm
3	Wilber meets Charlotte
4	Charlotte made the web with words TERRIFIC
5	The Ables, Zuckermans and all the animals go to the fair
6	Tempelton crawls through fair to find words for Charlotte
7	Charlotte Dies
8	Wilber meets 3 of Charlotte's children

http://www97.intel.com/FlashTools/VisualRanking/DataIO/VRDataIO.aspx?strProjectNa... 5/10/2006

Figure 15. Teacher 3's example of student work that exceeded expectations.

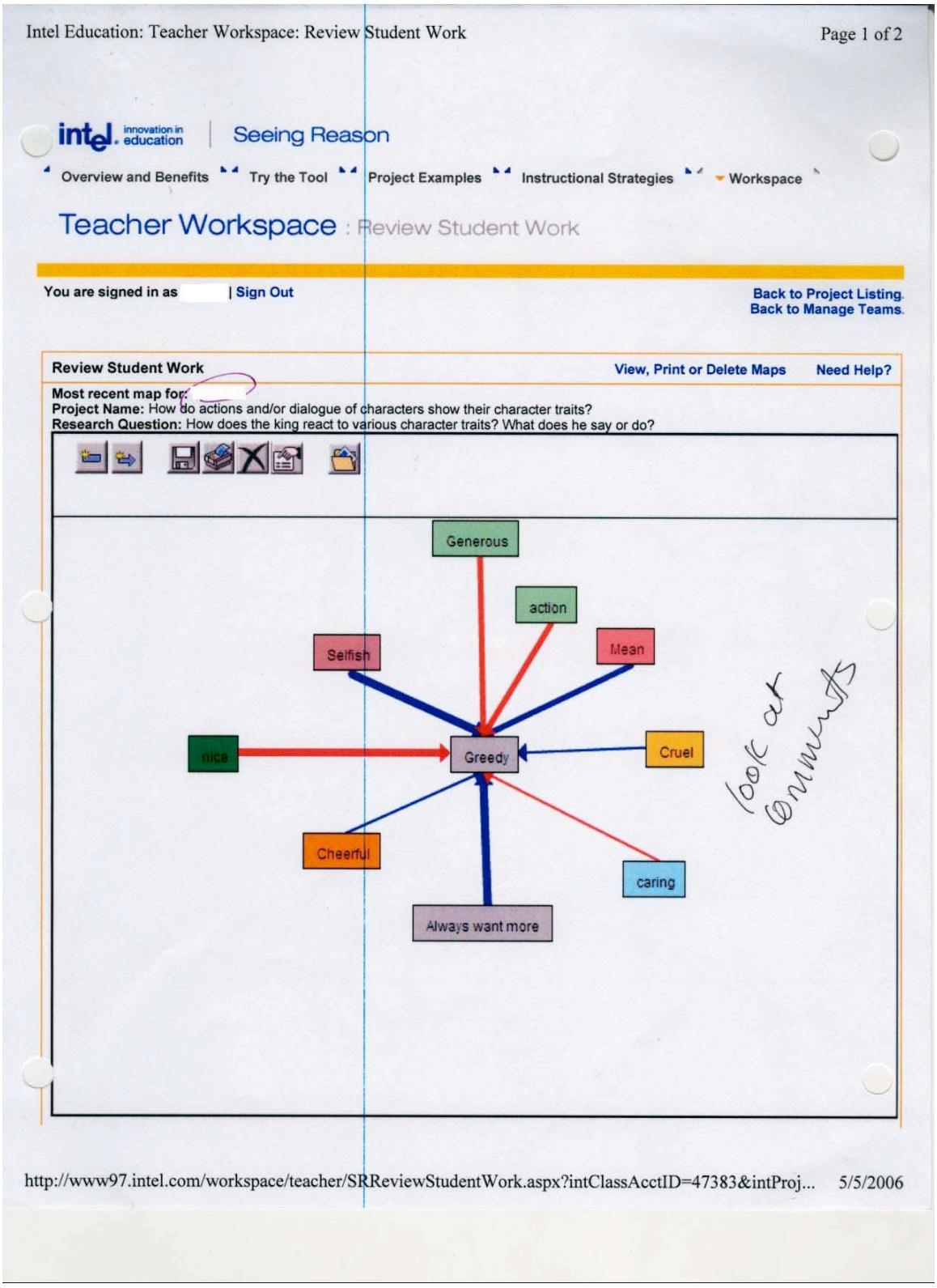


Figure 15 continued

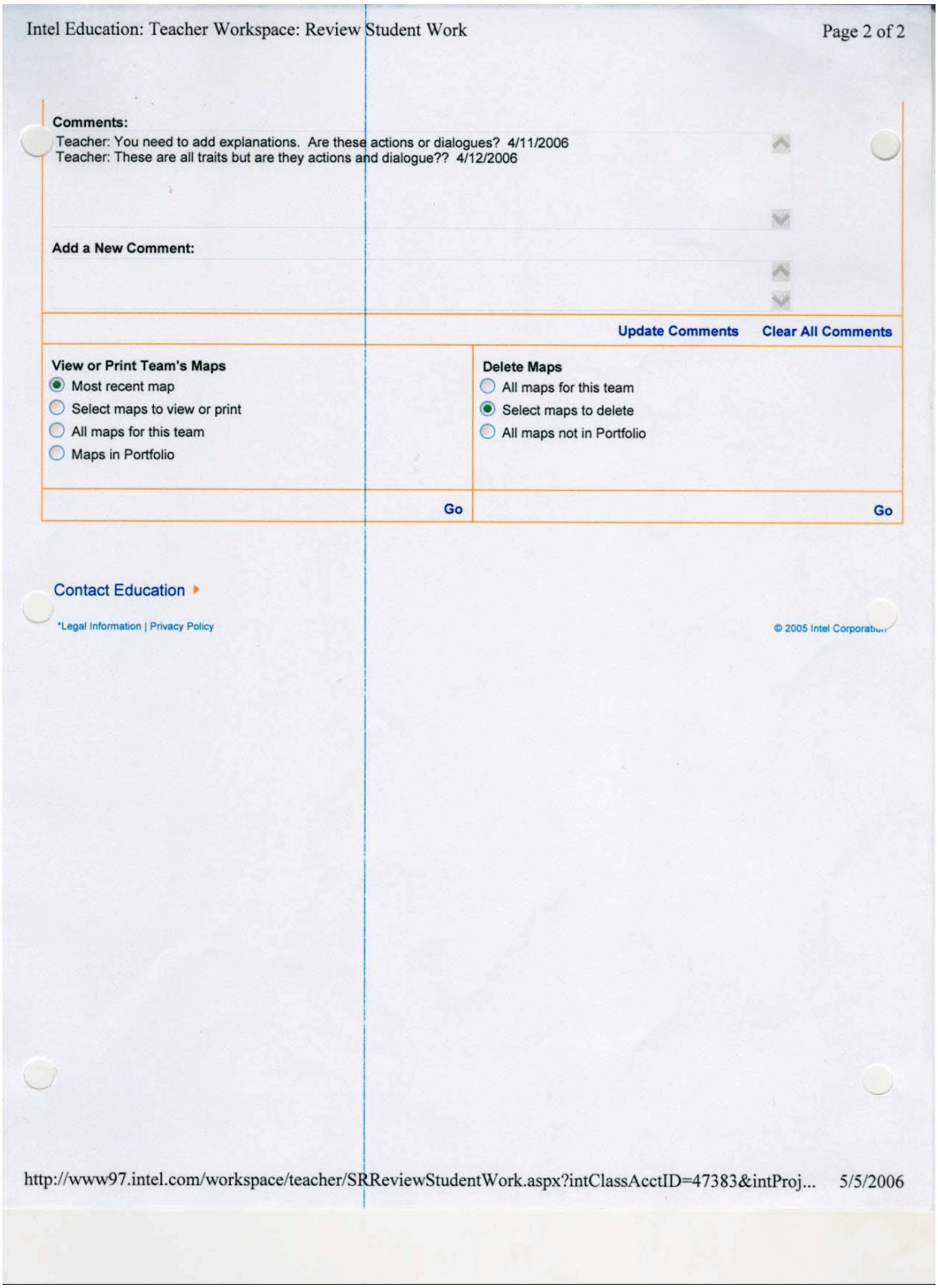
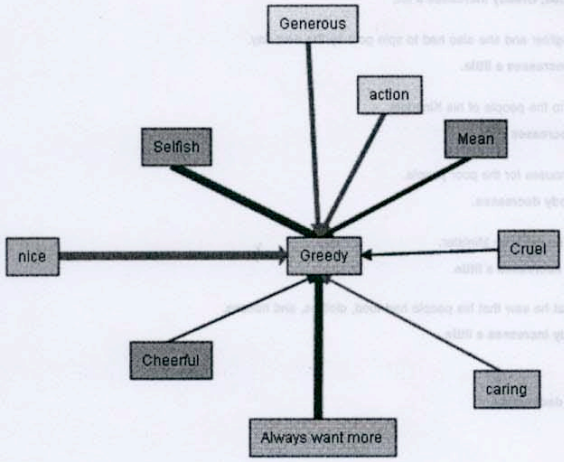


Figure 15 continued

Most Recent Map

Project Name: How do actions and/or dialogue of characters show their character traits?
Project Description: How do various character traits affect how the king reacts in the story? Think about what he does and says that affects how he reacts and what happens in each case?
Research Question: How does the king react to various character traits? What does he say or do?
Investigator ID:
Map Date: 4/13/2006 8:33:37 AM (PST)
Iteration: 4



Factors

Greedy
To the King, he would do anything for gold even if it meant that his kingdom was gonna fall apart, he always had gold on his mind.

As Selfish increases, Greedy increases a lot.

As Mean increases, Greedy increases.

As Always want more increases, Greedy increases a lot.

As Cruel increases, Greedy increases a little.

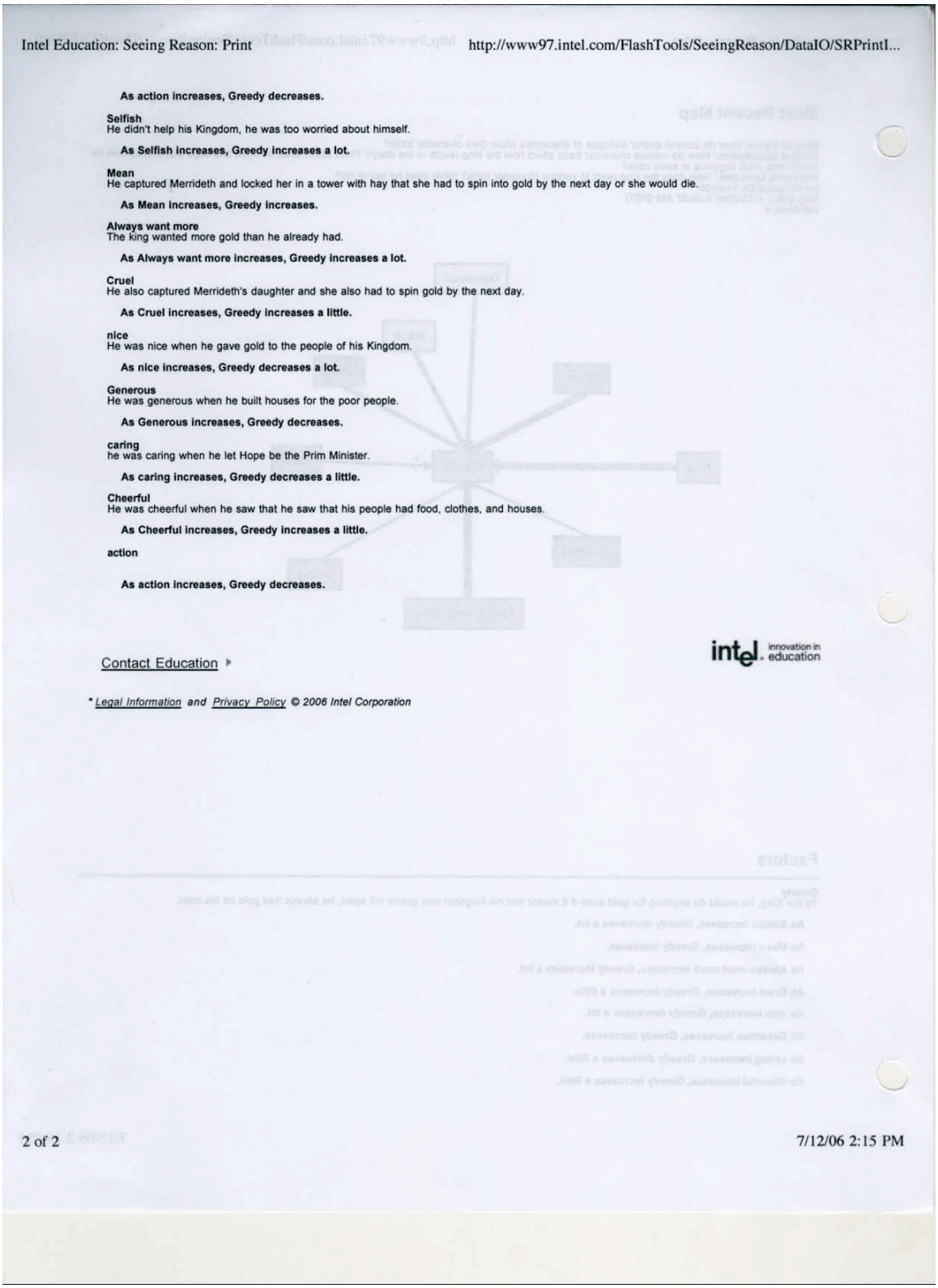
As nice increases, Greedy decreases a lot.

As Generous increases, Greedy decreases.

As caring increases, Greedy decreases a little.

As Cheerful increases, Greedy increases a little.

Figure 15 continued



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As action increases, Greedy decreases.

Selfish
He didn't help his Kingdom, he was too worried about himself.

As Selfish increases, Greedy increases a lot.

Mean
He captured Merrideth and locked her in a tower with hay that she had to spin into gold by the next day or she would die.

As Mean increases, Greedy increases.

Always want more
The king wanted more gold than he already had.

As Always want more increases, Greedy increases a lot.

Cruel
He also captured Merrideth's daughter and she also had to spin gold by the next day.

As Cruel increases, Greedy increases a little.

nice
He was nice when he gave gold to the people of his Kingdom.

As nice increases, Greedy decreases a lot.

Generous
He was generous when he built houses for the poor people.

As Generous increases, Greedy decreases.

caring
he was caring when he let Hope be the Prim Minister.

As caring increases, Greedy decreases a little.

Cheerful
He was cheerful when he saw that he saw that his people had food, clothes, and houses.

As Cheerful increases, Greedy increases a little.

action

As action increases, Greedy decreases.

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Figure 16. Teacher 3's example of student work that met expectations.

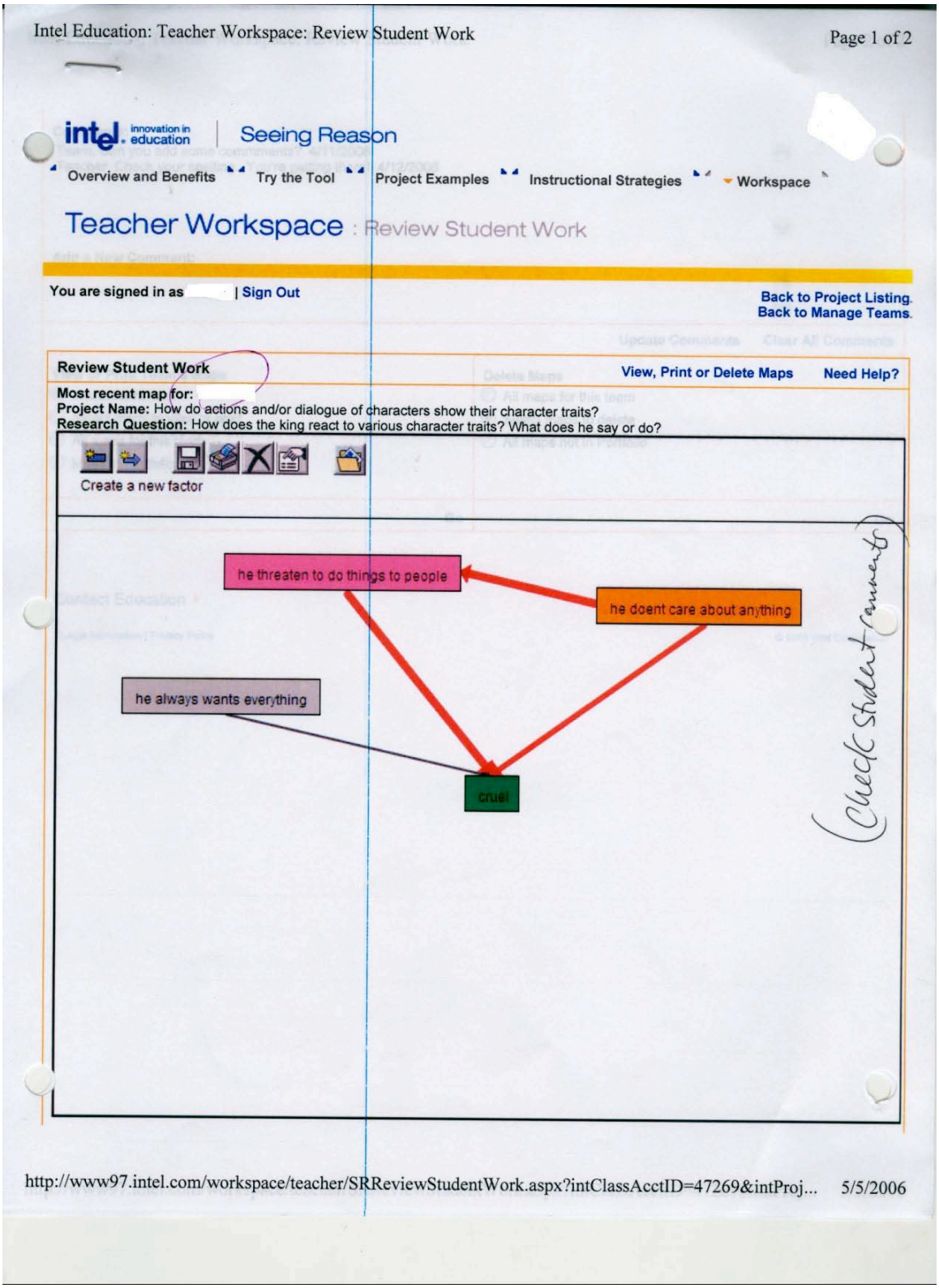


Figure 16 continued

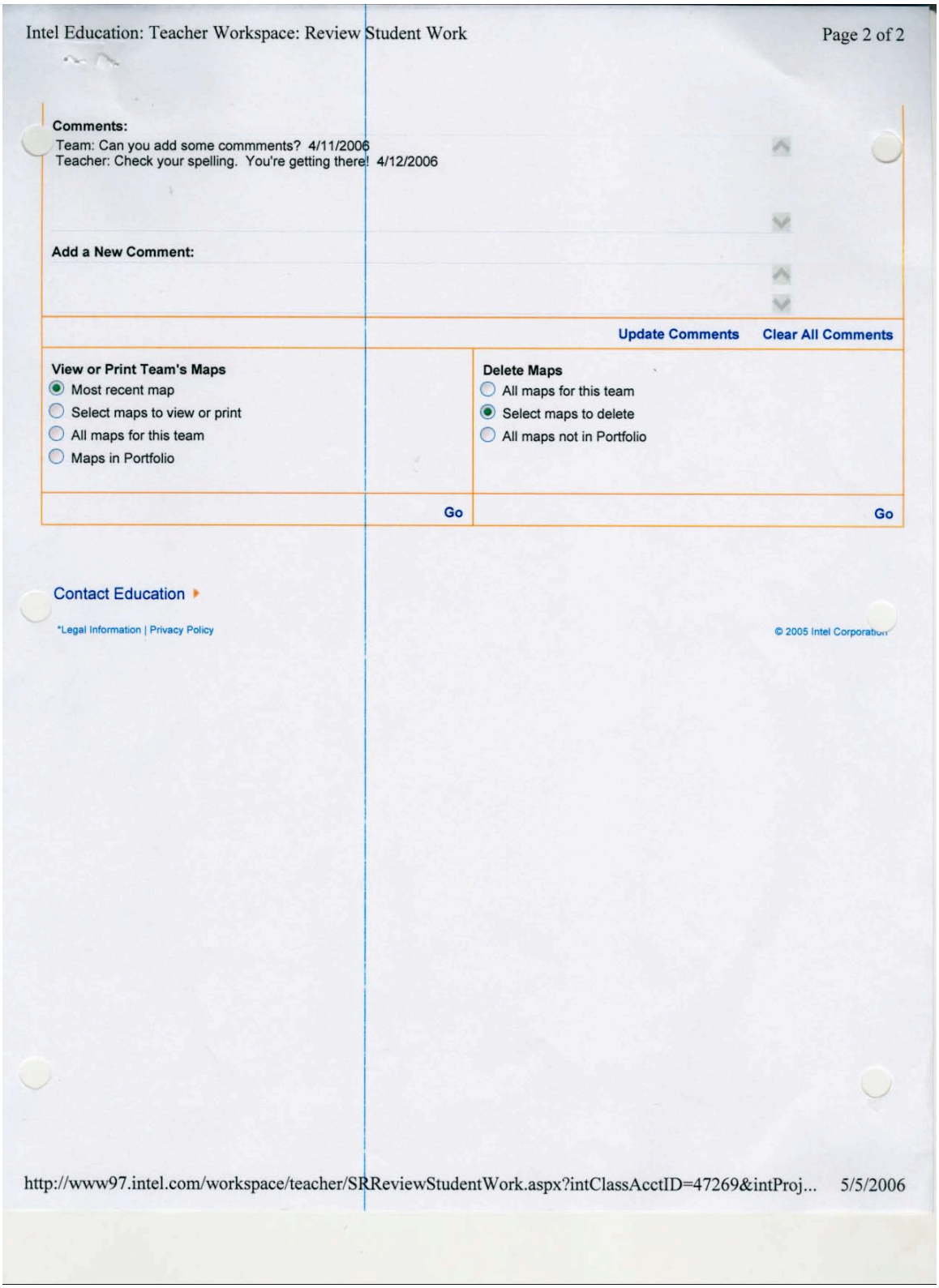
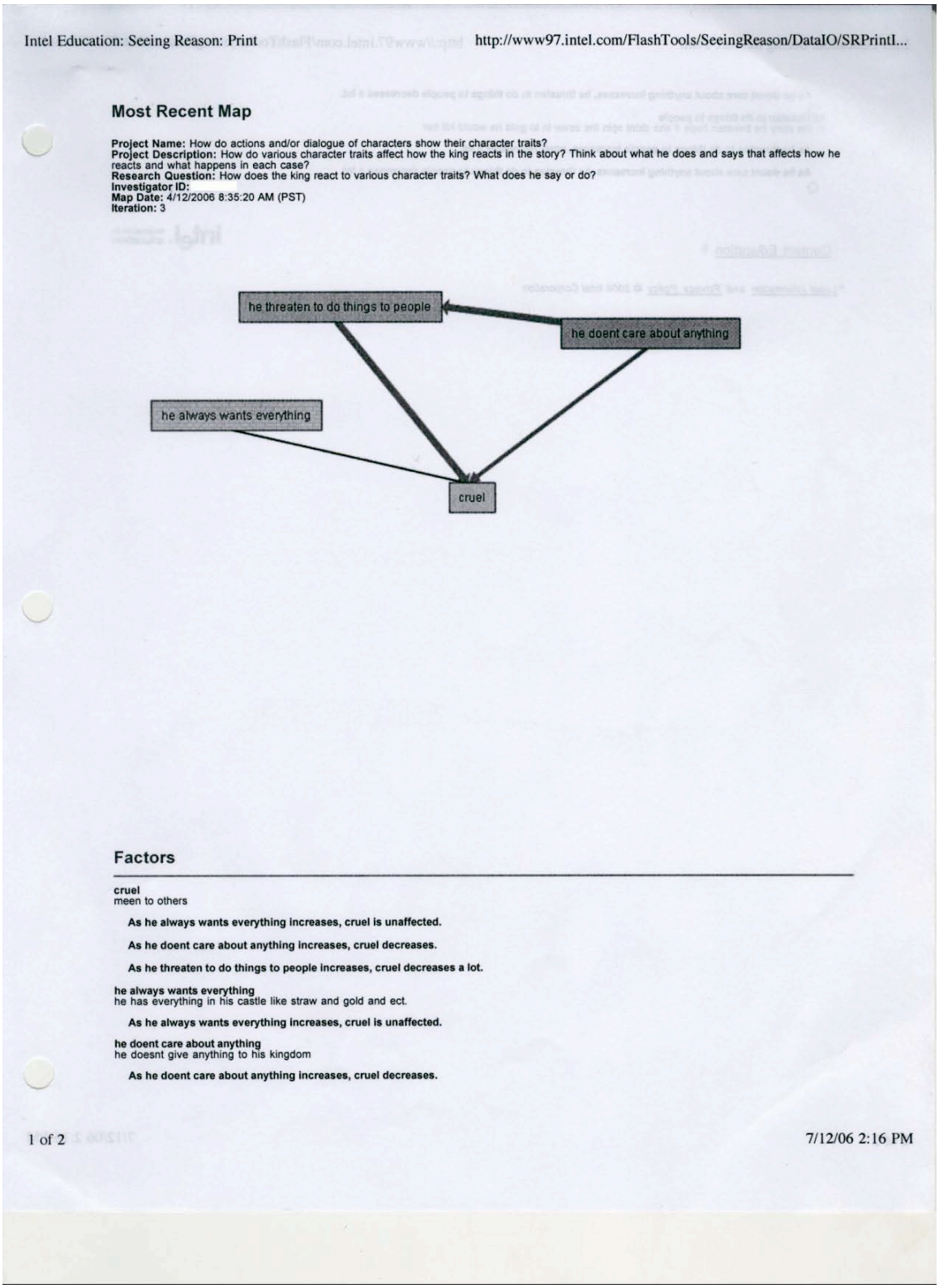


Figure 16 continued



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Most Recent Map

Project Name: How do actions and/or dialogue of characters show their character traits?
Project Description: How do various character traits affect how the king reacts in the story? Think about what he does and says that affects how he reacts and what happens in each case?
Research Question: How does the king react to various character traits? What does he say or do?
Investigator ID:
Map Date: 4/12/2006 8:35:20 AM (PST)
Iteration: 3

Factors

cruel
meen to others

As he always wants everything increases, cruel is unaffected.

As he doent care about anything increases, cruel decreases.

As he threaten to do things to people increases, cruel decreases a lot.

he always wants everything
he has everything in his castle like straw and gold and ect.

As he always wants everything increases, cruel is unaffected.

he doent care about anything
he doesnt give anything to his kingdom

As he doent care about anything increases, cruel decreases.

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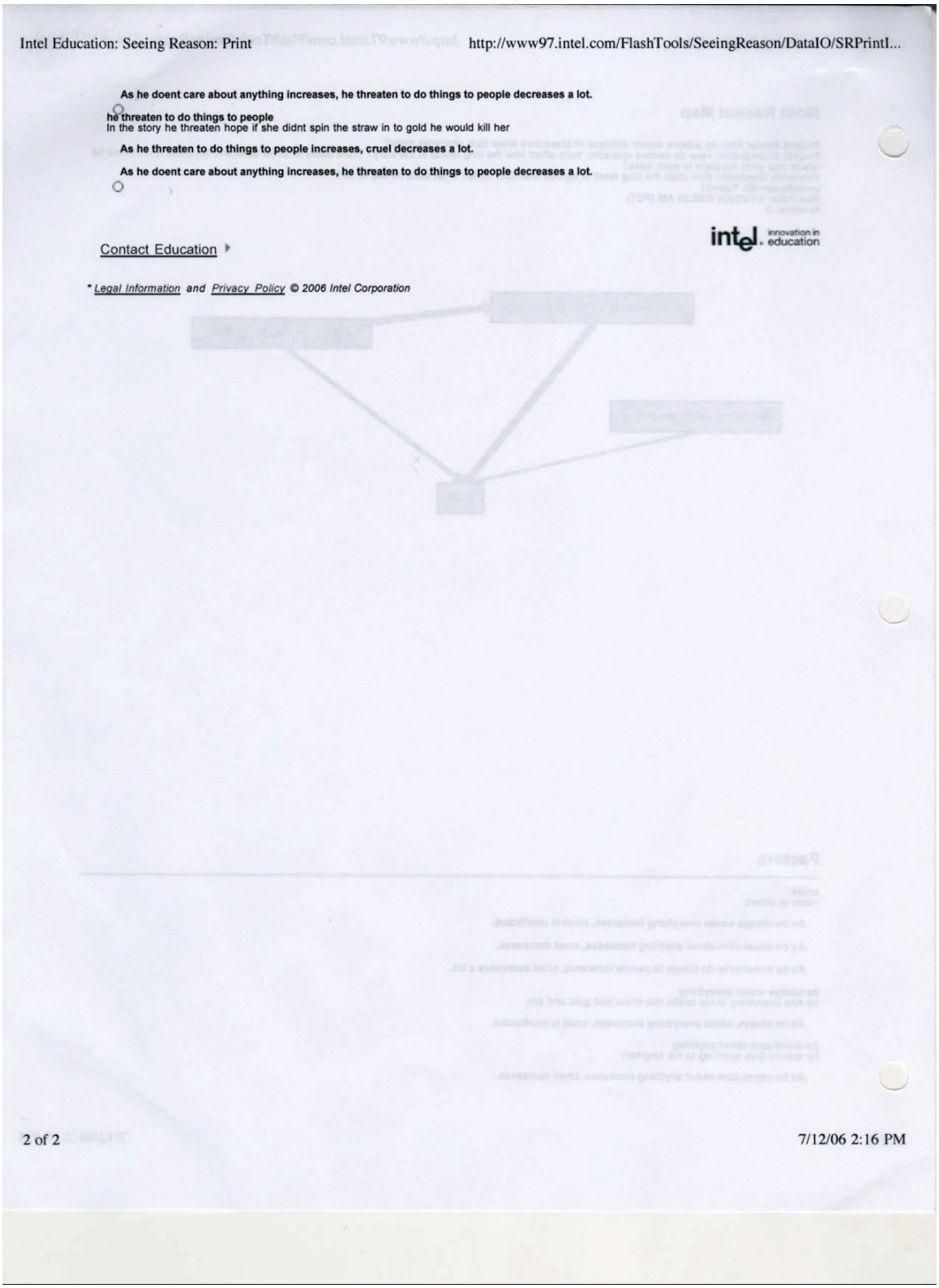
Figure 16 continued



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As he doent care about anything increases, he threaten to do things to people decreases a lot.

he threaten to do things to people
In the story he threaten hope if she didnt spin the straw in to gold he would kill her

As he threaten to do things to people increases, cruel decreases a lot.

As he doent care about anything increases, he threaten to do things to people decreases a lot.

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Figure 17. Teacher 3's example of student work that did not meet expectations.

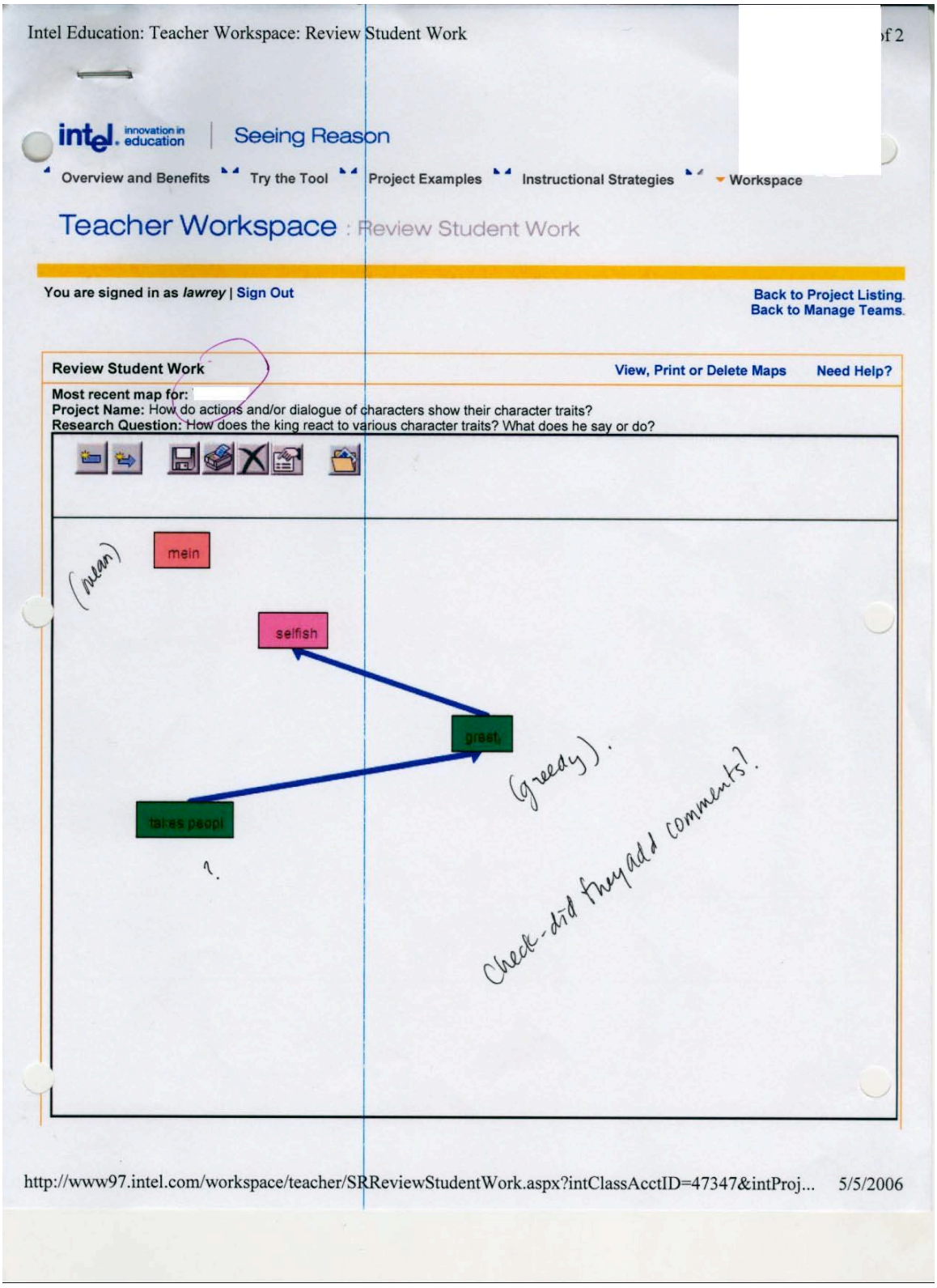


Figure 17 continued

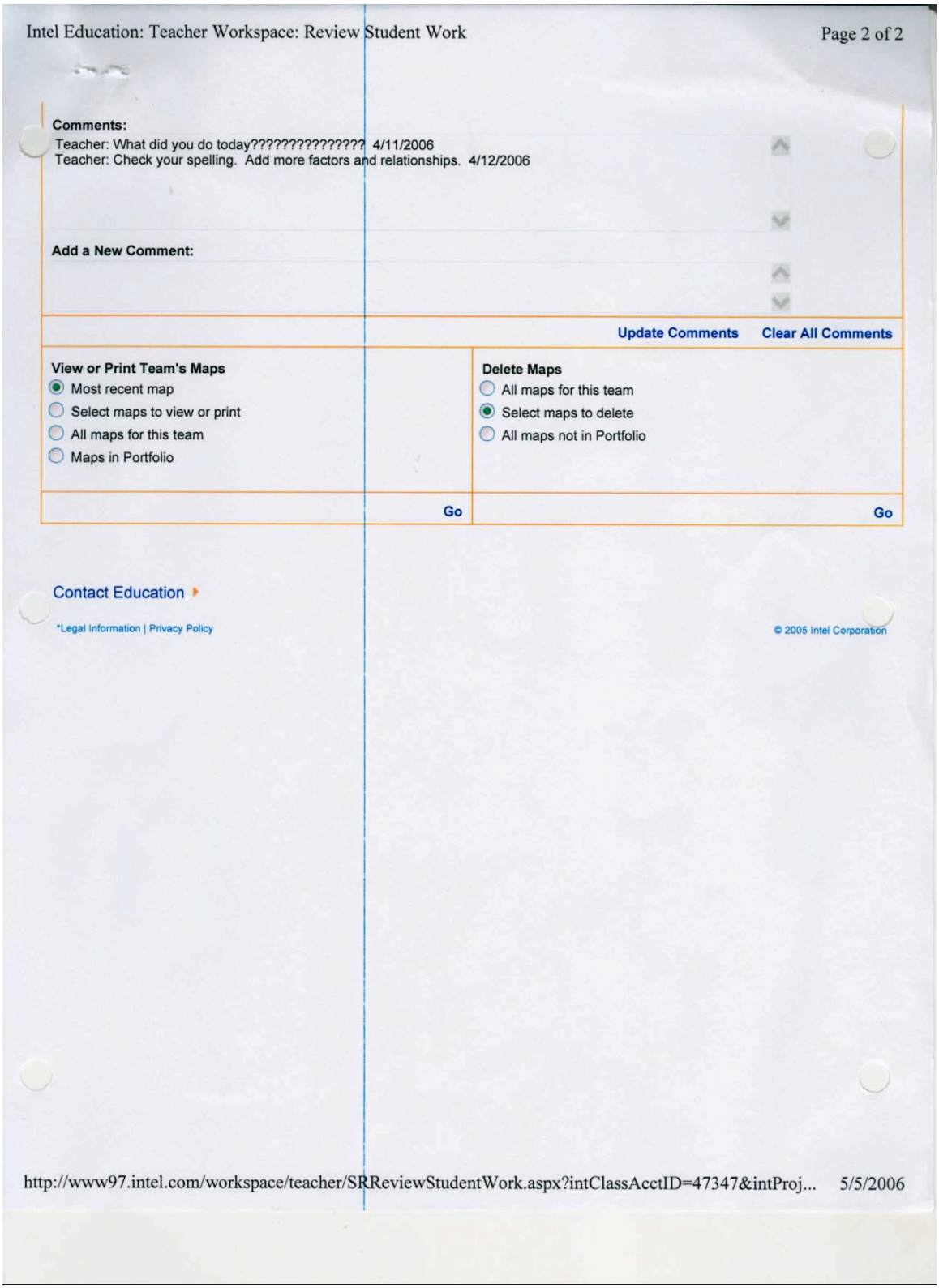
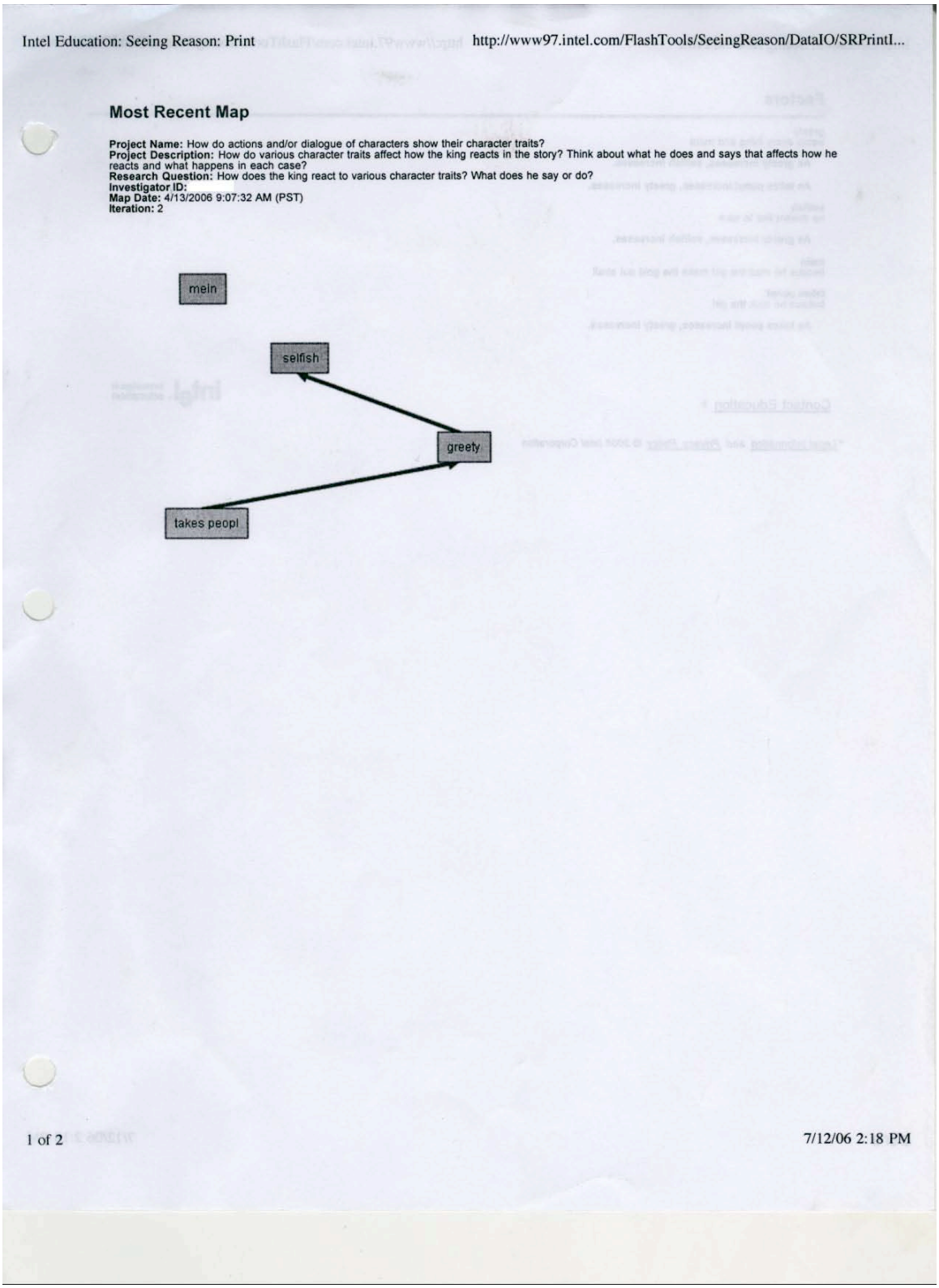


Figure 17 continued



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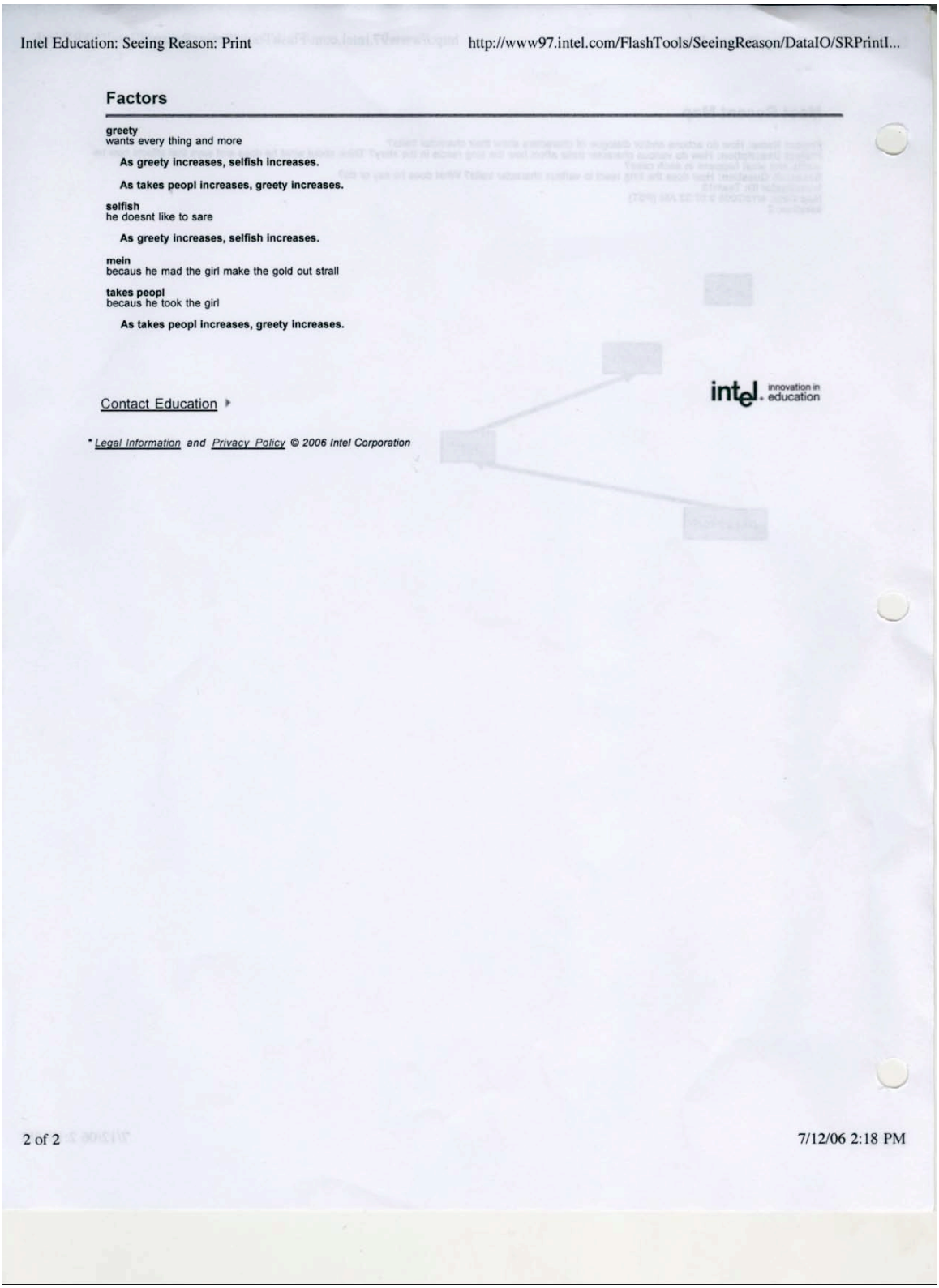
Most Recent Map

Project Name: How do actions and/or dialogue of characters show their character traits?
Project Description: How do various character traits affect how the king reacts in the story? Think about what he does and says that affects how he reacts and what happens in each case?
Research Question: How does the king react to various character traits? What does he say or do?
Investigator ID:
Map Date: 4/13/2006 9:07:32 AM (PST)
Iteration: 2

1 of 2 7/12/06 2:18 PM

Figure 17 continued



Intel Education: Seeing Reason: Print http://www97.intel.com/FlashTools/SeeingReason/DataIO/SRPrintI...

Factors

greety
wants every thing and more

As greety increases, selfish increases.

As takes peopl increases, greety increases.

selfish
he doesnt like to sare

As greety increases, selfish increases.

mein
becaus he mad the girl make the gold out strall

takes peopl
becaus he took the girl

As takes peopl increases, greety increases.

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APPENDIX F: STUDENT WORK SAMPLES (END PRODUCTS)

Before our site visits, we asked teachers to extract three examples of student work: an example that met the teacher's expectations, one that exceeded expectations, and one that did not meet expectations. We asked them to do this for the tool artifacts (examples seen in Appendix E) and for any end products of the unit (examples seen here).

Figures 18 – 20: Pictures of students' end products of Teacher 4's math unit on 3-D shapes.

Figures 21 – 24: Pictures of students' end products of Teacher 2's science unit on biomes.

Figure 18. This picture shows examples of the unfolded end products of Teacher 4's math unit on 3-D shapes. From left to right are examples of student work that: exceeded her expectations, met her expectations, and did not meet her expectations.

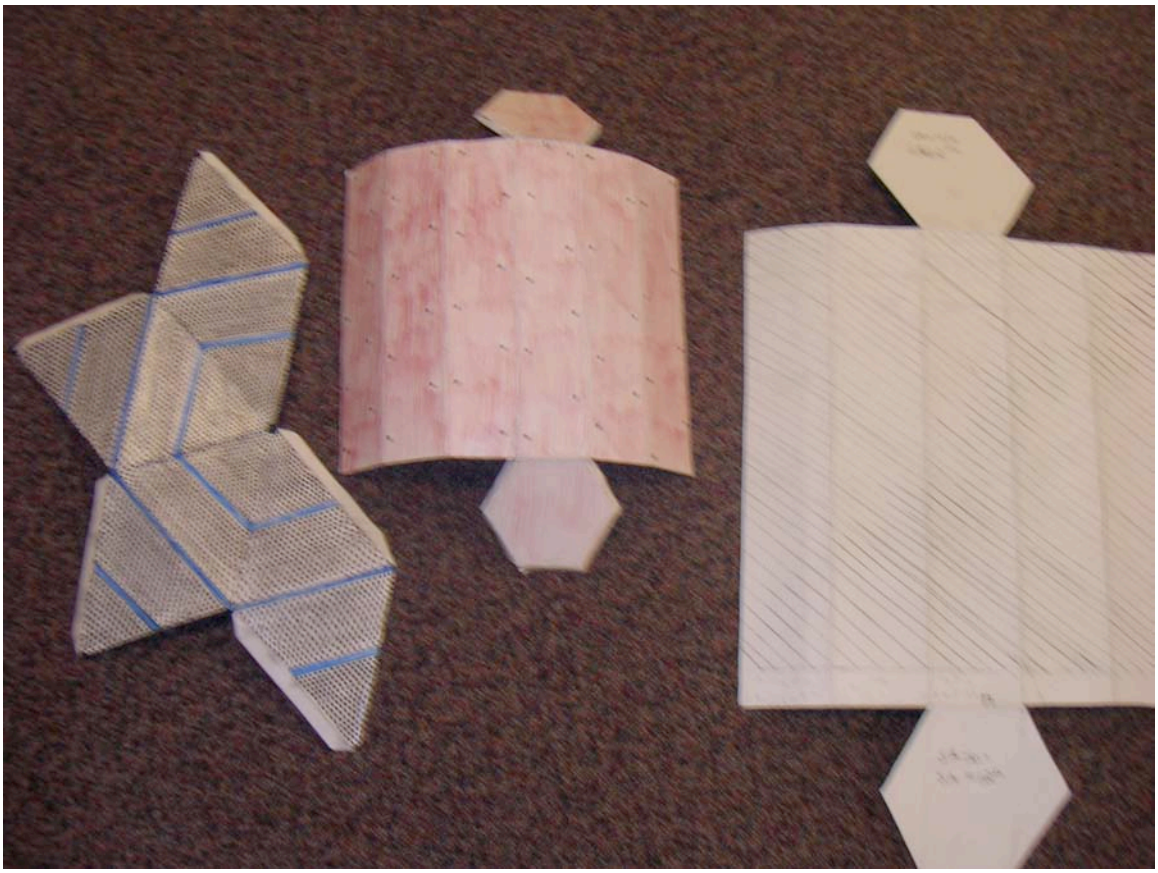

Figure 19. This picture shows an additional example of an unfolded end product of Teacher 4's math unit on 3-D shapes.

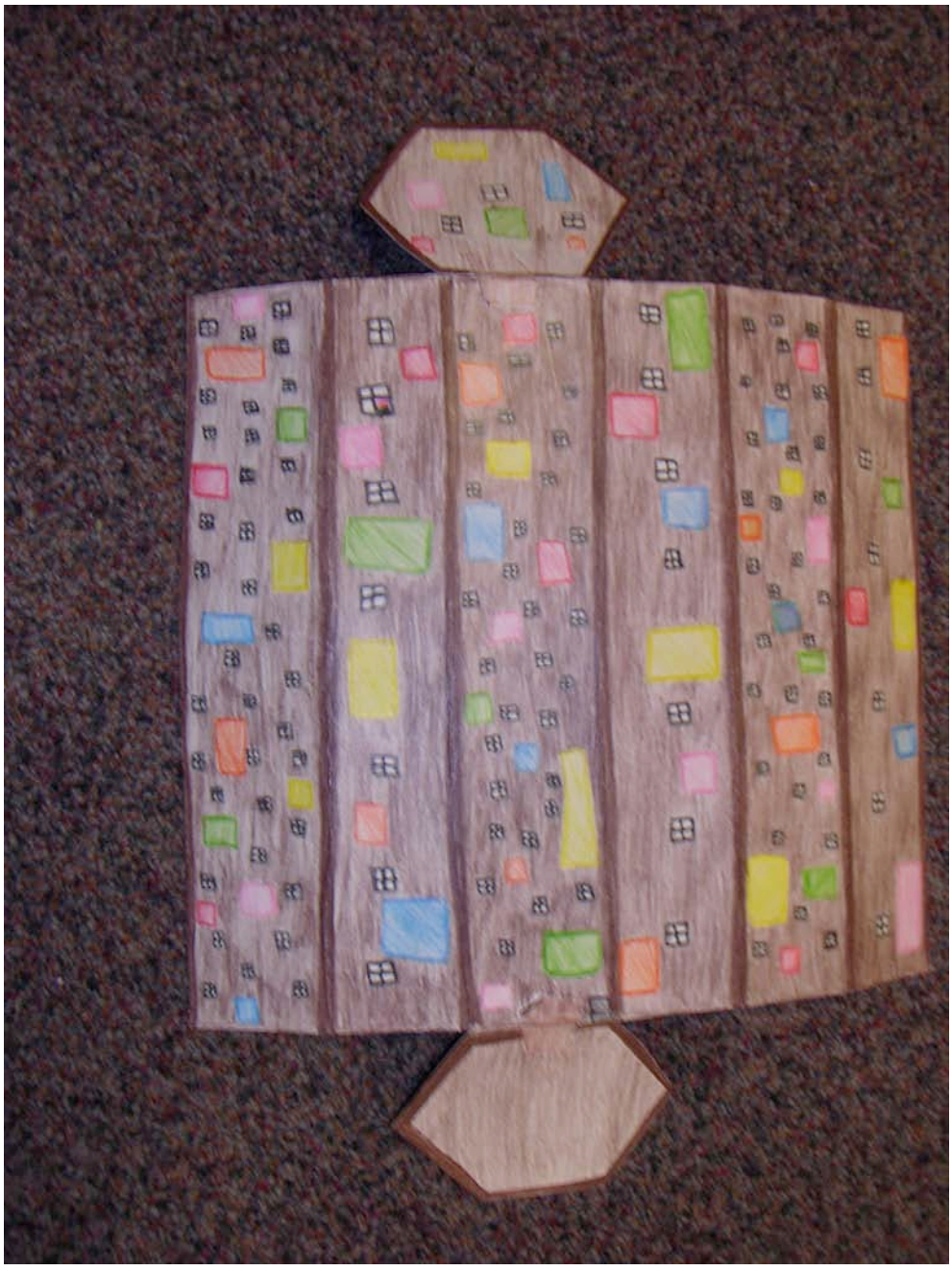

Figure 20. This picture shows all of the folded and fully completed student products of Teacher 4's math unit on 3-D shapes.

Figure 21. This picture shows an example of an end product of Teacher 2's science unit on biomes that exceeded Teacher 2's expectations.

Figure 22. This picture shows an example of an end product of Teacher 2's science unit on biomes that met Teacher 2's expectations.

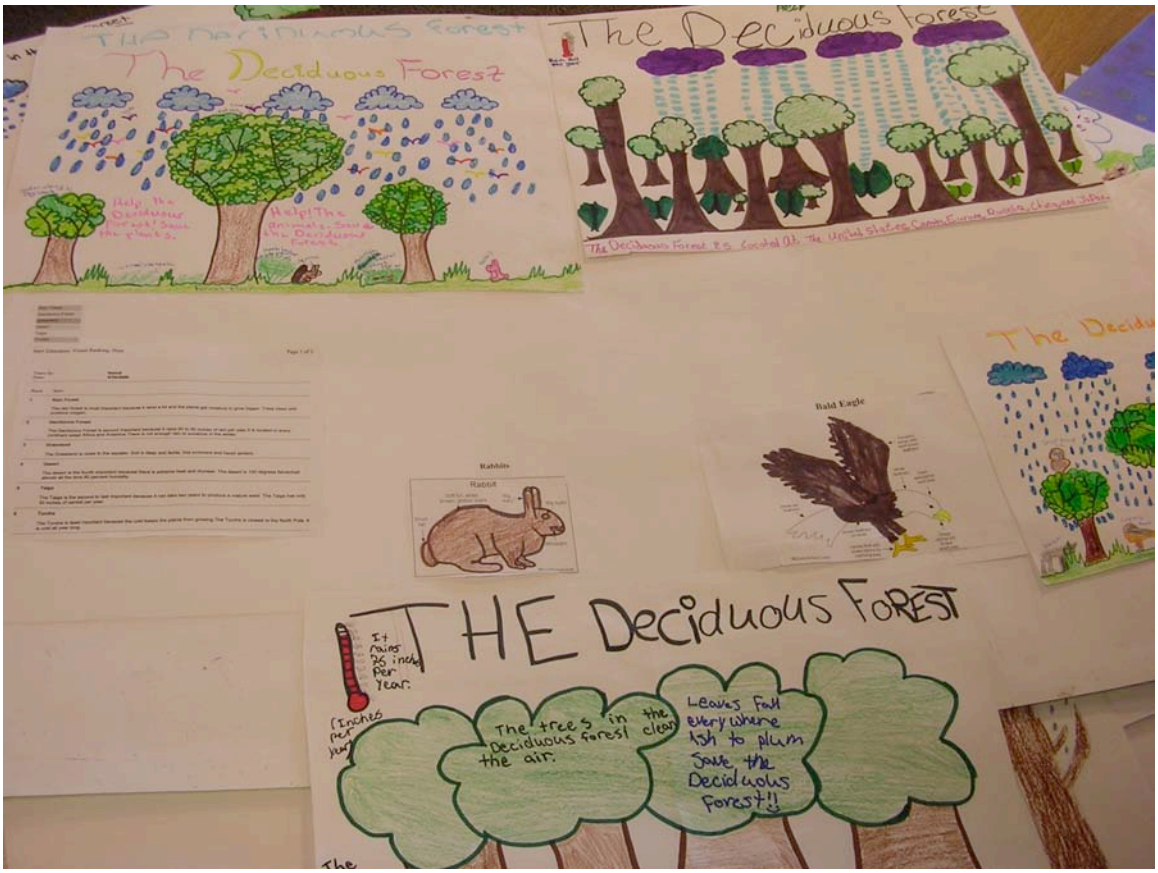

Figure 23. This picture shows an example of an end product of Teacher 2's science unit on biomes that did not meet Teacher 2's expectations.

Figure 24. This picture shows an additional example of an end product of Teacher 2's science unit on biomes.