Formative Evaluation of the Intel® Teach to the Future Workshop on Teaching Thinking with Technology (U.S.) 2005 REPORT

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Executive Summary
Formative Evaluation of the Intel® Teach to the Future Workshop on Teaching Thinking with Technology (U.S.) 2005 Report

This report presents findings from a formative evaluation of the Intel® Teach to the Future Workshops on Teaching Thinking with Technology, conducted by Education Development Center, Inc.'s Center for Children and Technology (EDC/CCT). The workshops are part of a portfolio of professional development programs supported by the Intel Innovation in Education initiative, and are designed to prepare teachers to use web-based software in their classrooms. Each of the three tools addressed in the training are intended to help students represent their thinking visually and to collaborate around 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 posed the following formative research questions, with a goal of generating insight into current program implementation and follow-up to inform further refinement of the program.

- How and to what extent does the training shape participants' understanding and use of the tools and associated resources?
- How do participants who have gone through the training, and their students, make use of the workshop resources?

Data sources gathered in the course of this formative evaluation included surveys, observations, communications with regional program administrators, trainers, and teachers, and sample unit plans collected from teachers.

Key findings: Successes and challenges

<u>Successes</u>

This formative evaluation found substantial evidence that the workshops are well received by the majority of their participants and that key concepts about using the tools in a project-based context are being effectively communicated and translated into practice. Specific findings suggestive of program success include the following:

- Participants and students find the online thinking tools engaging, innovative, easy to learn and technically simple to navigate.
- Participants leave the workshop focused on using the tools in a project-based context, and the unit plans they develop are consistent with this approach.
- Many participants report using the tools in their classrooms after the workshop, particularly *Visual Ranking*.
- Participants are most interested in using the tools to make student thinking visible and to promote comparison and discussion of student ideas, two activities that they value and believe to be stimulating for their students .

Challenges

This formative evaluation also identified some challenges to the program's success, primarily related to the program's goal of engaging and enhancing students' higher order thinking skills. Specific findings regarding the challenges of supporting students' higher-order thinking skills include the following:

- During the workshop, participants do not explore in depth how to use the tools to scaffold student use of specific thinking skills, and their unit plans do not typically include activities or instructional strategies that would provide that scaffolding.
- In observed classrooms, participants did not use the tools to support activities that contribute to the systematic development of higher-order thinking skills, such as sustained collection or rigorous evaluation of evidence, or drawing conclusions about the validity or strength of hypotheses or conclusions.

Two additional challenges were identified in the evaluation.

- Teachers of elementary grades, mathematics teachers and foreign language teachers consistently raised concerns about the relevance of the tools to their work with students. These teachers also exhibit lower rates of follow-up tool use in the classroom.
- A substantial minority of participants reported that it was difficult to gain access to the hardware and Internet connections they needed to support whole-class use of the tools.

Implications

The workshops are generating substantial teacher enthusiasm for "making thinking visible" and for provoking lively discussion in the classroom, two crucial features of a project-driven classroom in which students build deep understanding of content and exercise their critical thinking skills. However, the workshop is not yet adequately preparing teachers to guide their students through the equally important stages of defining good questions, setting criteria and procedures for gathering evidence, and evaluating and presenting evidence, and in particular is not directing them toward using specific features and functions of the online thinking tools to support these activities.

The workshops are familiarizing teachers with the features of appropriate social scaffolding to support student learning, but are not exposing teachers to the amount of detailed exploration of the available technological scaffolding that they need in order to be prepared to use the tools to stimulate and extend students' use of specific higher-order thinking skills. Without more deliberate deployment of the tools in follow-up classroom activities, use of the online thinking tools is unlikely to have an impact on students' mastery of either content or the higher-order thinking skills these workshops seek to support.

To build on their existing strengths and provide even deeper learning experiences for teachers, the workshops will need to engage teachers in more active learning, particularly structured reflection on their current practice and examination of artifacts of student learning. These approaches could help teachers to move beyond using the

tools to stimulate discussion in general, toward stimulating discussion that requires students to analyze, critique, compare and defend the ideas the online thinking tools have helped them to develop.

Many teachers are leaving the workshops interested in the tools, engaged with the idea of making their students' thinking visible, and motivated to use technology in a project-based context in their classrooms. But achieving a more substantive shift in teachers' knowledge and practice of supporting student inquiry, the workshops will need to move away from the delivery of information and toward supporting teachers' own inquiry into how they, and their students, can build new knowledge through the use of these tools.

Recommendations

Communicate early and often that these tools provide a window into students' thinking. The idea that the online thinking tools make students' thinking visible was the most broadly recognized and most enthusiastically received perspective on the relevance of the tools to everyday classroom practice.

Engage teachers in discussions of student work in core content areas. Replace trainer-driven instructional time during the workshop with discussions and team activities that invite teachers to unpack examples of each stage of development of a student project.

Prepare trainers to discuss how the features of the tools scaffold specific components of the learning process. Trainers need to be prepared and prompted to draw teachers beyond learning to use the tools procedurally and into an exploration of specific tool features as supports for student learning.

Address the practicalities of classroom implementation of the tools and associated units or projects in more detail. Less experienced classroom technology users need more guidance during the workshop to ensure that they feel prepared enough to make the leap to experimenting with the tools in the classroom.

Address the needs and concerns of K-5 teachers. If the workshops are truly intended for a K-12 audience, a significant effort needs to be made to develop more examples of how to integrate the tools into elementary grade classrooms, and trainers need to be prepared to address the needs of this large group of teachers.

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I. Introduction

This report presents findings from a formative evaluation of the Intel® Teach to the Future Workshops on Teaching Thinking with Technology, conducted by Education Development Center, Inc.'s Center for Children and Technology (EDC/CCT). The workshops are part of a portfolio of professional development programs supported by the Intel Innovation in Education initiative, which has three core objectives:

- To improve teaching and learning through the effective use of technology
- To advance mathematics, science and engineering education and research
- To advocate for and celebrate 21st century educational excellence.

The workshops address the first of these objectives by preparing teachers to use web-based cognitive scaffolding tools in their classrooms to support the development of students' 21st century skills. Intel Innovation in Education programs define this skill set with reference to the work of the Partnership for 21st Century Skills (2003) and the International ICT Literacy Panel (2002), and place particular emphasis on developing students' ability to think critically, communicate effectively and collaborate. To accomplish this goal, the training engages teachers with two intersecting topics: project-based approaches to teaching and learning and the use of web-based software, referred to as online thinking tools, to support students' use of specific metacognitive strategies.

The online thinking tools can be used to support an enormous range of activities, but the workshops specifically model and encourage use of the tools in a project-based context. The curriculum is structured to take participants through a step-by-step process of building curricular units that are grounded in specific questions or claims. Trainers follow and build on modular cues as they walk participants through the practicalities of this process. 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 is designed to allow each participant to produce a

complete unit plan, a tangible resource that is tied to their instructional objectives and that they can take back to their classroom to implement.

The workshops are delivered using a train-the-trainer model: district-level Master Teachers are trained by Senior Trainers and are encouraged to then turn around the training to at least ten teachers locally. Senior Trainers are trained as a group by the Institute of Computer Technology (www.ict.org). Senior Trainers are responsible for training Master Teachers on the Essentials Course and/or the Workshop on Teaching Thinking with Technology. Workshops are modular, and include 24, 32 or 40 hours of face-to-face classroom time, depending on whether teachers are introduced to one, two or three of the online thinking tools. All Master Teachers are trained on all three tools in a 40-hour training.

Each of the three web-based tools addressed in the training are intended to help students represent their thinking visually and collaborate around 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.

Research Framework

The Workshop on Thinking Teaching with Technology was developed in part to provide a "next step" training to teachers who have completed the Intel Teach to the Future Essentials Course, a 40-hour training focused on student use of productivity tools (i.e., Microsoft Office) in a project-based context (see http://www.intel.com/education for more information about the program, and http://www2.edc.org/cct/teachfuture.asp for evaluation findings related to this program). The Essentials Course was highly successful at orienting teachers toward a certain type of classroom technology integration: it

emphasized putting the technology into students' hands, tying technology use directly to project-based work and providing teachers with the practical tools they needed to make classroom implementation of technology-rich unit plans realistic. However, the Essentials Course did not dig deeply into helping teachers consider how technology use per se could have a specific impact on either the depth of students' content knowledge or the development of their higher-order thinking skills. Instead, this training sought to help teachers integrate information and communication technology (ICT) tools into their teaching to help their students conduct research and communicate their findings and ideas with others.

In contrast, the Workshop on Teaching Thinking with Technology seeks to train teachers both in how to use technology with students in a project-based context, and in how to structure students' use of a specific set of technology tools to improve their higher-order thinking skills. A teacher completing a workshop successfully should return to his or her classroom armed with both a repertoire of instructional and curricular strategies to support project-based teaching and learning and an understanding of how the online thinking tools can best be deployed to scaffold and extend student learning.

Key features of the program. The research literature on effective professional development (Darling-Hammond, Lieberman & McLoughlin, 1995; Dede, 1998; Garet, Porter, Desimone, Birman & Yoon, 2001; National Commission on Teaching and America's Future, 2003) suggests that by both helping teachers develop concrete instructional strategies and building their insight into students' learning processes, the workshop is directly addressing important teacher needs. This research suggests that programs are most likely to lead to changes in instruction, and then to improvements in student learning, when the content of the professional development offering provides teachers with three things:

1. Concrete instructional practices and curricula that can be taken directly back to the classroom
2. Insight into how students go about learning specific content or developing conceptual knowledge

3. A deeper understanding of content.

The Workshop on Teaching Thinking with Technology builds on the success of the Intel Teach to the Future Essentials Course by placing a strong emphasis on the first of these features. In a workshop, as in the Essentials Course, teachers are invited to create unit plans that will fit directly into their current teaching; to link the material covered in the training to their own content area and the needs of their own students; and to create materials that will work within the logistical and practical realities their classrooms.

The workshop also takes on a new challenge, one not explicitly addressed by the Essentials Course, by addressing the second element described above, by directly engaging teachers in the study of how students learn to draw upon and strengthen specific metacognitive skills. The suite of tools, *Visual Ranking*, *Seeing Reason* and *Showing Evidence*, is designed to scaffold specific metacognitive strategies, such as judging the relative importance of various pieces of evidence and analyzing multivariate relationships. In order to use these tools effectively, teachers need access to models of how students acquire and assimilate these thinking skills, so that they can develop and implement appropriate activities, and accurately diagnose and guide students as they move through units or lessons that make use of these tools.

Like the Essentials Course, the workshop does not directly address building teachers' content knowledge. The Intel Teach to the Future programs are strategically designed to meet the needs of all teachers, regardless of their content specialization, and to introduce teachers to technology tools that can enhance teaching in any content area. Consequently, like the Essentials Course, the workshop is designed to encourage teachers to dig into and explore their own content area. It offers a range of examples of how the tools can be used across various content areas and grade levels, but is not targeted to teachers in any particular content area. By offering a uniform professional development experience to teachers across all grades and content areas the workshop could become a powerful lever for broad improvement of ICT use within schools and school districts, At the level of the individual teacher, however, this approach could also be challenging, because the teacher alone is responsible for either bringing adequate

content knowledge to bear on the training experience or seeking out the content expertise he or she needs to guide and strengthen his or her use of the online thinking tools.

Bringing ICT tools and instructional strategies together. The professional development literature (Garet, Porter, Desimone, Birman & Yoon, 2001; Kennedy, 1999) suggests that in order to have an impact on student learning the concrete ideas and materials teachers take back to the classroom with them need to embody both the instructional ideas (facilitating project-based learning) and the ideas about student learning (the higher-order thinking skills that the online thinking tools are intended to scaffold) that are communicated in the workshop. The primary challenge from the perspective of a workshop participant, then, is to envision, understand, and enact the simultaneous management of a particular instructional context (a classroom focused on project-based learning, at least for a particular time period) and a particular set of interactions with the technology (effective use of the online thinking tools).

Roy Pea, in an article about the relationship between technology and student learning, refers to this two-part equation as a relationship between *social scaffolding* and *technological scaffolding* (2004). Pea uses "social scaffolding" to refer to the particular configuration of time, space, resources and instruction in the classroom in which students learn and corresponds to the workshop's focus on establishing instructional practices and curriculum in the classroom that foster project-based learning and associated forms of teaching. "Technological scaffolding" refers to the functions and capabilities of the software that facilitate students' exercising of particular skills or practices — the resources that extend a student's ability to think and explore in new learning domains.

This distinction points clearly toward the crucial qualities of effective instruction and effective use of technology in the classroom. In each case, resources need to be designed and deployed to support students by extending their reach — by bringing their cognitive skills and ability to ask and answer questions into broader, deeper, and more

complex territory than they could navigate on their own. From a professional development perspective, this means that teachers need to develop both instructional skills – the ability to draw on time, space, and materials to structure high-quality student learning experiences in the classroom, and an understanding of how to deploy specific features of technology effectively to support students' emergent learning. If teachers are able to use the tools effectively, in a project-based context, students will have the opportunity to build a deeper understanding of the conceptual material and cognitive skills the tools are intended to support, and, by extension, to understand new aspects of content.

Implications for the evaluation. This theory of action about the likely pathway toward successful outcomes for this professional development program leads to the following formative research questions. These are posed in order to generate findings not about the outcomes of the program, but about whether and how the program is being implemented and what obstacles and opportunities exist to improve program implementation so that positive outcomes are most likely to result.

- How, and to what extent, does the training shape participants' understanding and use of the tools and associated resources?
  - What elements of the online tools themselves support or impede participants' process of learning how to use them well?
  - What elements of the workshop curriculum and associated support materials support or impede the participants' process of learning the key content presented in the workshop?
  - How do participants' prior knowledge and local context shape the delivery of individual workshops and teachers' experiences of those workshops?
- How do participants who have gone through the training, and their students, make use of the workshop resources?
  - What are the key opportunities for and obstacles to effective use of the online thinking tools in the classroom (such as technical obstacles, beneficial curricular connections, etc.)?

- To what extent is participants' classroom follow-up (such as using the online thinking tools with students) consistent with the instructional practices and learning goals the resources are intended to support?
- How do participants' prior knowledge and local context shape the scope, depth, and persistence of their classroom follow-up?

Organization of the Report

This report presents the results of a formative evaluation of the Intel Teach to the Future Workshops on Teaching Thinking with Technology, which were piloted in spring 2005 and launched in June 2005. After a review of methods and data sources and an overview of the backgrounds of program participants, findings are presented, followed by a discussion of key findings and a set of recommendations.

II. Methodology and Data Sources

This section provides a brief overview of data sources gathered in the course of this formative evaluation, which include surveys; observations; communication with regional program administrators, trainers, and teachers; and sample unit plans collected from teachers.

Surveys

Surveys, collected both at the end of the training experience as well as weeks or months following the workshop, provide a broad measure of participants' responses to the curriculum, the online thinking tools and associated instructional strategies. Web-based surveys were administered throughout the program's implementation and responses were analyzed quarterly.

End-of-Training Survey, Master Teachers. All Master Teachers completing the Workshop on Teaching Thinking with Technology responded to an end-of-training survey administered via the Intel Teach to the Future extranet. The Intel/ICT Team transmits survey data to EDC/CCT on a quarterly basis; data is then cleaned and checked, and descriptive analyses are run using SPSS. Eight hundred and eleven Master Teachers were surveyed between June 23 and November 18, 2005, and 790 responded, representing a response rate of 97%.[1]

End-of-Training Survey, Participant Teachers. All Participant Teachers completing the Workshop on Teaching Thinking with Technology for each agenda type (one tool — *Visual Ranking* only; two tools — *Visual Ranking* and *Seeing Reason* or *Visual Ranking* and *Showing Evidence*; and all three tools — *Visual Ranking*, *Seeing Reason* and *Showing Evidence)* are also asked to respond to an end-of-training survey. The administration of this survey, and data collection and analysis procedures, are identical to those for the Master Teacher survey described above. Five hundred and ninety-nine Participant

[1] These numbers were obtained from Intel/ICT records and reflect the numbers of Master Teachers trained between June 23 through November 18, 2005, based on classes in "completed" status on the Intel extranet. See Appendix A for a detailed description of program participants and Appendix B for frequencies of the Master Teacher responses to the End-of-Training Survey.

Teachers were surveyed between June 23 and November 18, 2005, and 387 responded, representing a response rate of 65%.[2]

Follow-up Survey. A follow-up survey was administered to both Master Teachers and Participant Teachers who had been trained on the Workshop on Teaching Thinking with Technology between June 24 and October 14, 2005, a population that included 699 Master Teachers (considered "Certified" and "Active" as trainers) and 123 Participant Teachers (those who submitted end-of-training surveys during this time period).[3] These surveys explored whether and how teachers had made use of the online thinking tools in their classrooms, teachers' perceptions of the obstacles to and benefits of using the tools, and teachers' reflections on their training experiences. The surveys also requested information about the unit plan teachers created during the workshop. Master Teachers were also asked about whether and how they had delivered workshops locally. On October 27, 2005, the Intel/ICT Team sent an email blast to these two populations of teachers asking them to complete the online survey. On November 3, 2005, a reminder email blast was sent. On November 11, 2005, the Intel/ICT Team provided the returned email counts for both distribution lists (twelve returned emails for Master Teachers and two for Participant Teachers). Between October 27 and November 13, 2005, 194 Master Teachers and 24 Participant Teachers completed the survey (a response rate of 28% for Master Teachers and 20% for Participant Teachers). The resulting data sets were then cleaned, checked and analyzed using SPSS. Due to the small number of Participant Teachers in the response pool, their responses are not reported here.

Observations

Direct observation of instruction, whether in a training setting or a teacher's own classroom, provides a rich portrait of how a programmatic theory of action gets translated into real instructional practice. Structured protocols were used to guide all

[2]These numbers were obtained from Intel/ICT records and reflect the numbers of Participant Teachers trained between June 23 through November 18, 2005, based on classes in "completed" status on the Intel extranet. See Appendix A for a detailed description of program participants and Appendix C for frequencies of the Participant Teacher responses to the End-of-Training Survey across the four agenda formats.

[3] See Appendix D for frequencies of the Master Teacher responses to the Follow-up Survey.

observations. All field notes were written up following a uniform structure, which facilitated systematic comparison across observations.

Workshop observations. Evaluation team members observed portions of two Master Teacher workshops and eight Participant Teacher workshops between August and November 2005 (see Table 1 below for details). Site selection drew on both lists of scheduled Master Teacher and Participant Teacher workshops on the Intel extranet system and Senior Trainer and Master Teacher responses to EDC/CCT's contacts and requests. See Table 2 for a summary of the recruitment process relative to the universe of scheduled trainings.

Observations paid particular attention to documenting the trainers' delivery of the curriculum and participants' responses to and ways of engaging with the curriculum as delivered. Regarding the trainer, the protocol prompted specifically for documentation of trainers' modifications of the substance and timing of the workshop agenda; trainers' explanations of key concepts; and their techniques for engaging teachers in discussion. Regarding the participants, the protocol prompted specifically for documentation of the timing and content of questions asked, teacher productivity and level of engagement during work periods on the computers, evidence of teacher engagement with and response to information presented and questions posed by the trainer, and evidence of teacher use of the tools during work periods on the computers. Observers also spoke informally with the trainer and individual teachers, gathering contextual information about the local school district, teachers' prior knowledge and expectations of the training, and the trainer's reflections on the current training experience, the needs and priorities of the participating teachers, and their own perceived strengths and weaknesses as trainers.

Table 1: Overview of Workshop Observations

Workshop	Type of Training	Tools Covered	Parts of training attended*	Tools used during observation	Location	Trainer	No. of Teachers
1	Master Teacher	3 tools	Beginning Middle End	*Visual Ranking* *Seeing Reason* *Showing Evidence*	Northeast Urban/ Suburban district	Senior Trainer – (Essentials Course, Workshop, & previous 2 tool Workshop)	15
2	Master Teacher	3 tools	Beginning Middle	*Visual Ranking* *Seeing Reason*	Mid-west Large urban district	Senior Trainer – (Essentials Course, Workshop, & previous 2 tool Workshop)	8
3	Participant Teacher	3 tools	Beginning (2nd session)	*Visual Ranking* *Showing Evidence*	South Large urban district	Master Teacher/ former Senior Trainer – (Essentials Course, Workshop)	20+
4	Participant Teacher	2 tools (VR, SR)	Middle End	*Visual Ranking* *Seeing Reason*	South Rural district	Senior Trainer/ Master Teacher – (Essentials Course, Workshop)	5
5	Participant Teacher	3 tools	Middle	*Seeing Reason*	South Small city district	Master Teacher – (Workshop)	A=6 B= 5
6	Participant Teacher	3 tools	Beginning	*Visual Ranking Seeing Reason*	South Suburban district	Master Teacher – (Workshop)	12
7	Participant Teacher	3 tools	Beginning	*Visual Ranking Seeing Reason*	South Suburban district	Master Teacher – (Workshop)	12
8	Participant Teacher	3 tools	Beginning	*Visual Ranking Seeing Reason*	Northeast Suburban district	Master Teacher – (Essentials Course, Workshop, & previous 2 tool Workshop)	9
9	Participant Teacher	3 tools	Middle	*Showing Evidence*	Mid-west Rural district	Master Teacher – (Essentials Course & Workshop)	10
10	Participant Teacher	3 tools	End	*Visual Ranking Seeing Reason* *Showing Evidence*	Mid-west Rural district	Master Teacher – (Workshop)	4

* *Beginning* = Introductory modules where Curriculum-Framing Questions and Thinking Models are introduced and initial hands-on activities with *Visual Ranking* and *Seeing Reason* tools occur. *Middle* = Modules where one or more of the tools are used to develop project ideas. *End* = Final modules where unit plans are completed and the Showcase occurs.

Table 2: Summary of Workshop Recruitment Processes and Scheduled Trainings

	Total trainings completed through November 2005*	Recruitment timeframe and process	Total number observed/responded
Master Teacher Workshops	52 (18 cancelled)	July. Three Senior Trainers contacted, two confirmed trainings.	Observed two trainings in Summer 2005
Participant Teacher Workshops	61 (8 cancelled, 9 in "approved status")	September-October. Fifty-five Master Teachers contacted, 35 responded, 17 had trainings scheduled during fall semester, 16 were willing to host a site visit.	Observed eight trainings in Fall 2005
Classroom visits	N/A	Sept.-Oct.-Nov. Seventeen RTA Coordinators, 36 Senior Trainers, 24 Master Teachers, and 7 Participant Teachers were contacted for leads on teachers using the tools with students during the fall semester. Two RTA Coordinators and 0 Senior Trainers provided contacts.	Observed five teachers, fifteen classes in Fall 2005

* These numbers were obtained from Intel/ICT records.

Classroom observations. Evaluation team members observed 15 different classroom implementations of the online thinking tools in five school districts. See Table 3 for a summary of classrooms included in this sample. These observations were conducted in November and December 2005. Sites for classroom observations were identified based on teachers' responses to requests for information about planned use of the tools prior to the winter break period. These requests were disseminated through follow-up surveys and on-going interactions with Master Teachers at workshop trainings. Researchers followed up on all responses and attended all classroom implementations that were identified and scheduled to take place before data collection was concluded in mid-December. The sample of classroom implementations includes primarily classes delivered by computer teachers, a group that is well represented within the Master Teacher population overall (approximately 30% of all Master Teachers surveyed report being technology coordinators, computer teachers or library media specialists). This group of Master Teachers is more likely than most other participants to report having already used the online thinking tools in their own classrooms. The sample is also skewed toward applications of *Visual Ranking*, which is consistent with findings from the

Follow-up Survey that suggest that most teachers who do use the tools after completing the workshop choose to use *Visual Ranking*, either exclusively or before moving on to the other tools.

Classroom observations were conducted in a manner similar to observations of trainings, with a structured protocol guiding the collection of key data points that are supplemented by a running narrative of the lesson as it unfolds in the classroom. The collection of the running narrative is also structured and documents teachers' words and actions at key moments in the lesson – such as their initial introduction of the structure and function of the online thinking tool or tools, or their method of posing the driving question of the lesson to their students. The narrative also documents student questions and discussions related to the use of the online thinking tools.

Table 3: Overview of Classroom Observations

Classroom Observation Visits	Teacher's Prior Participation in Intel Teach to the Future	Location	Tools Covered	No. of classes visited	Subject Area	Grade	No. of students
1	None. Supported by Senior Trainer in building	North-east Suburban district	Visual Ranking	2	Humanities / Gifted	8th	9
					Humanities / Gifted	8th	5
2	Master Teacher, Workshop	North-east Suburban district	Visual Ranking	5	Computers	3rd	18
					Computers	3rd	18
					Computers	3rd	18
					Computers	3rd	19
					Computers/ Special Ed	3rd	9
3	Senior Trainer, Essentials Course & Workshop	South Large urban district	Showing Evidence	3	Physics	11th, 12th	6
					Physics	11th, 12th	8
					Physics	11th, 12th	13
4	Master Teacher, Workshop	North-east Rural district	Visual Ranking	4	Computers	3rd	22
					Computers	3rd	23
					Computers	3rd	24
					Computers	3rd	22
5	Participant Teacher, Essentials Course & Workshop	Midwest Rural district	Seeing Reason	1	Physics	10th	12

Communication with Program Administrators and Trainers

Email reflections with RTA Coordinators. In May 2005, 17 RTA Coordinators were contacted via email by EDC/CCT, based on a contact provided by the Intel K-12 education team. Five RTA Coordinators responded and were interviewed by a member of the EDC/CCT research team, (a 29% response rate). The purpose of these contacts was to inquire about coordinators' experiences with recruitment efforts connected to Intel Teach to the Future programs (i.e. the Workshops on Interactive Thinking Tools, Workshops on Teaching Thinking with Technology, and the Leadership Forums), collect their responses to the marketing materials and messaging they had received to promote and recruit for the new Workshops on Teaching Thinking with Technology, identify any challenges they expected to encounter with recruitment efforts, and gather reflections about their experiences at the RTA Summit.

In mid-November 2005, the same 17 RTA Coordinators were contacted again, and four responded (a 24% response rate). RTA Coordinators were asked to share their perceptions of how teachers in their regions were responding to the Workshops on Teaching Thinking with Technology, what (if any) specific opportunities or challenges their district contacts had identified in relation to the content, objectives, and logistics of implementing the workshops locally, and their perceptions of the relevance of the workshop and the online thinking tools to local needs.

Email reflections with Senior Trainers. Thirty-six Senior Trainers were contacted via email in May 2005, using Senior Trainer contact lists provided by the Intel/ICT Team. Eleven Senior Trainers either responded by email and/or were interviewed by a member of the EDC/CCT research team over the phone (a 31% response rate). The purpose of this contact was to gather Senior Trainers' responses to their training on the Workshop on Teaching Thinking with Technology, the materials they received, their experiences at the Senior Trainer Summit, and how prepared they felt to conduct trainings, and to identify any challenges they expected to encounter related to the curriculum and tools.

Thirty Senior Trainers were contacted in mid-November, and nine responded (a 30% response rate). Senior Trainers were asked about their experiences conducting trainings and asked to identify successful strategies and challenging experiences they had encountered as a trainer thus far. They were also asked about Master Teachers' responses to the content and objectives of the workshop, the online thinking tools, and implementation logistics at the local level, and to share their perceptions of how relevant the workshop, materials, and project ideas were to local teachers.

Unit Plans

Thirty unit plans were collected from participants, either at the conclusion of a workshop attended by an evaluation team member, during a classroom visit, or from a Senior Trainer. Documentation collected included background information about the unit plan (e.g. subject area, grade level, length of unit, instructional strategies included), the higher-order thinking/21st century skills identified in the plan, the completed components of the unit itself, and a listing of the features and functions of the tools to be used. Unit plans were coded to capture uniform evidence of key features.

III. Overview of Program Participants

This section presents a brief overview of the backgrounds of the teachers who have participated in the Workshops on Teaching Thinking with Technology. See Appendix A for a detailed description of Master and Participant Teachers. Findings noted here reflect the responses of 790 Master Teachers and 387 Participant Teachers.

Professional role

Less than half of the responding Master Teachers are classroom teachers (46.4%), and close to a third are technology coordinators, media specialists or librarians (29.5%). A large majority of Participant Teachers are classroom teachers (85.5%). Six percent of Participant Teachers identified themselves as enrichment or resource teachers, followed by technology coordinators, media specialists or librarians (4.4%). Small numbers of both Master and Participant Teachers identified themselves as holding other professional roles in their districts. See Figure 1 for a summary.

Subject area taught

Those Master Teachers who teach core content areas are most likely to be general curriculum teachers (19.5%) and computer science teachers (15.6%), followed by English/Language Arts (9.8%), vocational/technical training (6.6%), professional development (5.8%), science (5.6%), math (5.4%), and social studies (4.8%). A small number of teachers report teaching in other content areas.

Participant Teachers are far more likely to be classroom teachers than Master Teachers. Most Participant Teachers teach in one of the core content areas, including general curriculum (26.2%), English/Language Arts (17.3%), science (10.2%), math (9.4%), special education (7.1%) and social studies/history (5.5%). A small number of participants report teaching in other content areas. See Figure 2 for a summary.

Grade level taught

About a third of the Master Teachers reported that they teach at the middle school level (35%) and 30% teach at the upper elementary grades. Close to a quarter teach at

the early elementary (26%) and the high school (23%). Twenty percent do not work with students directly.[4] Over a third of Participant Teachers teach in the early elementary grades (36.4%), and another quarter (25.3%) teach upper elementary grades. Close to a quarter teach at the high school (26.1%) and middle school (22.7%) levels. Only a few participants do not work with students directly (0.5%).[5] See Figure 3 for a summary.

Prior involvement with Intel Teach to the Future programs

Over a half of the Master Teacher respondents indicated they had previous involvement in Intel Teach to the Future programs. Forty-six percent reported having been trained as a Master Teacher for the Essentials Course, 11.6% had been Participant Teachers, and 5.4% were trained as both. Thirty-seven percent had not previously participated in the Essentials Course. A third of Master Teachers had previously been trained as Participant Teachers in an earlier version of the workshop (the Workshop on Interactive Thinking Tools). Only 10% of Master Teachers had participated in Leadership Forums, 4.1% as Master Leaders, and 6.2% as Participant Leaders.

Similarly, over half (55.9%) of responding Participant Teachers report having taken the Essentials Course as a Participant Teacher, and almost half report having taken part in the previous version of this workshop, the Workshop on Interactive Thinking Tools (44.2%)[6]. Very few had been trained as a Master Teacher for either program (0.9% Essentials Course, 1.3% previous Workshop). Almost all of the respondents had not previously participated in a Leadership Forum (97%), although a small number were trained as Participant Leaders (3%).

[4] The total exceeds 100% because participants could select all grade levels that applied.
[5] The total exceeds 100% because participants could select all grade levels that applied, including the 2005-2006 academic year.
[6] This response seems artificially high, and may reflect teacher misunderstanding of this question.

Figure 1: Professional role in schools or district

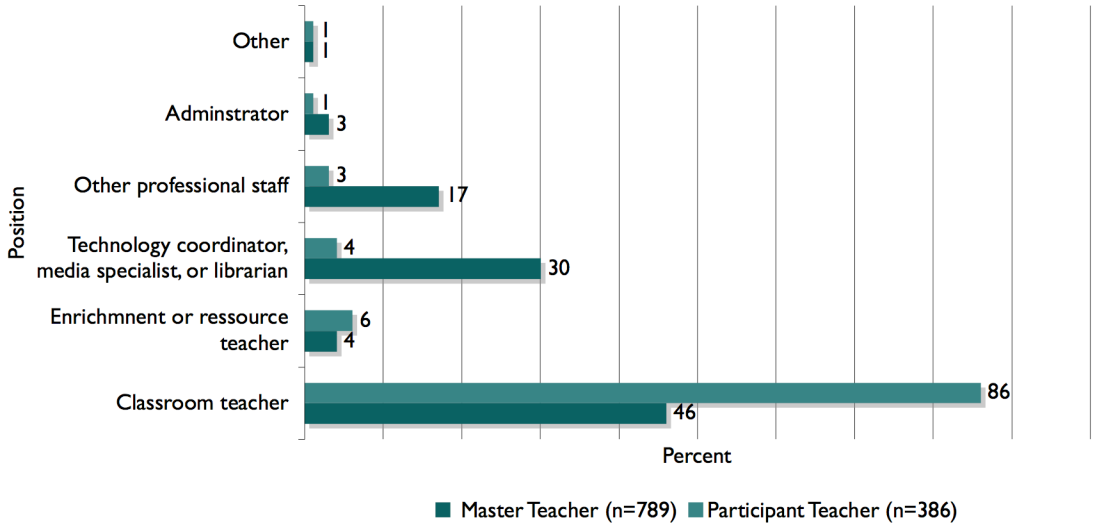


Figure 2: Primary Subject Area Taught

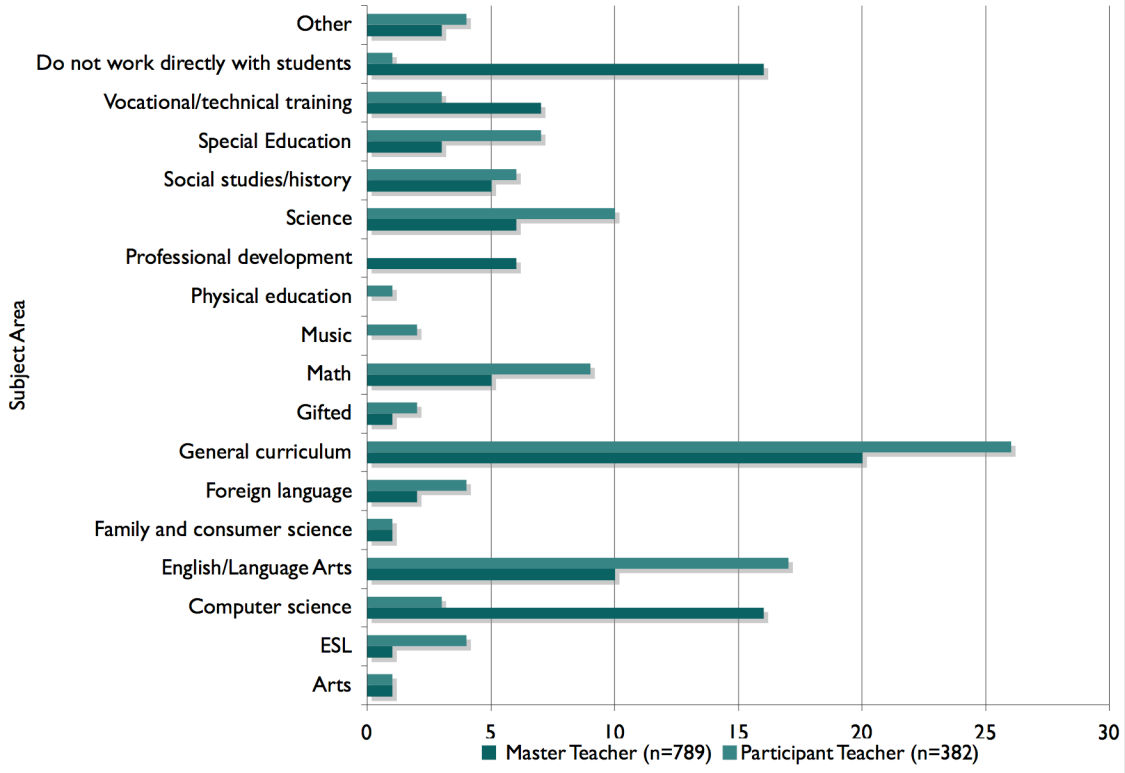
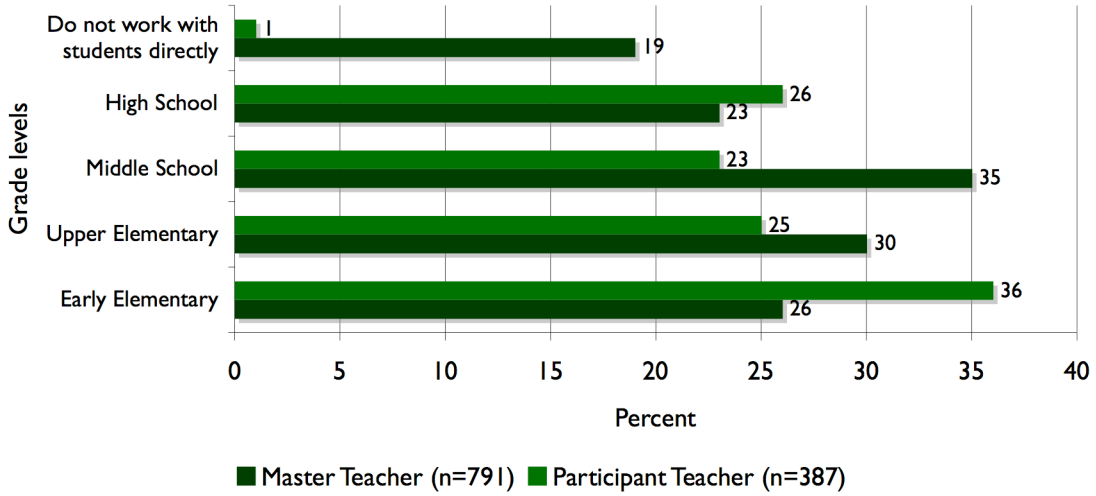


Figure 3: Grade levels taught during the 2005-2006 academic year



IV. Findings

This section presents findings related to the research questions presented above. It includes two sub-sections addressing the following topics: 1) How and to what extent the workshop shapes participants' understanding and use of the tools and associated resources, and 2) How participants who have gone through a workshop make use of the tools and associated resources once they have returned to their classrooms.

1) How workshops shape teachers' understanding of the tools and associated resources

Finding. *Nearly all participants acquire a basic technical understanding of how to use the online thinking tools in the course of the workshop. A minority became familiar with the correlation feature in Visual Ranking, the portfolio function in Seeing Reason, or how to use the full version of Showing Evidence.*

Both Master Teachers (82%) and Participant Teachers (78%) reported, in response to their End-of-Training surveys, that their trainer was "very successful" at helping them understand the online thinking tools and their workspaces. Both groups rated their trainers most highly on this item (see Table 4).

Table 4: Percentage of participants who felt their trainer was "very successful" at specific tasks

	Master Teachers (n=791)	Participant Teachers (n=164)
Help participants understand the tools and their workspaces	82.3	78
Expose participants to a project-based approach to instruction	79.4	76.8
Expose participants to overall scope and sequence of curriculum	78.4	77.4
Support the development of participants' project ideas	77.4	77.4
Model delivery of the workshop (Master Teachers only)	77	NA
Help participants understand student thinking through the taxonomies of learning	71.1	72
Help participants develop Curriculum-Framing Questions	71	73.2
Help participants prepare to manage tool use in the classroom	70.2	69.5
Help to develop assessments for projects	63.6	73

Both Master and Participant Teachers also indicated their trainers were well prepared to help them acquire an understanding of the tools and the basic processes each tool was designed to support, although Participant Teachers give their Master Teachers slightly lower ratings than Master Teachers gave to their Senior Trainers. See Table 5. This difference is consistent with some Senior Trainers' reports that Master Teachers often felt, at the conclusion of their own training, that they basically understood how to use the tools, but would definitely want to practice further with them before leading a training themselves. Since many of the Participant Teacher trainings included in these survey responses were led by Master Teachers who turned trainings around quickly after their own training, these Master Teachers may have had less time to practice using the tools than they would have liked prior to delivering a local training.

Table 5: Percentage of Teachers Who Reported the Trainer was "Adequately Prepared" or "Very Prepared" to Develop Tool-Specific Technical Skills

	Master Teachers (n=787)		Participant Teachers (VR, SR, SE; n=164)	
	Adequately Prepared	Very Prepared	Adequately Prepared	Very Prepared
Trainer helped participants through the process of creating a practice ranking list and project idea using the *Visual Ranking Tool*	10	87	14	84
Trainer helped participants through the process of creating a practice map and project idea using the *Seeing Reason Tool*	12	85	20	76
Trainer helped participants through the process of creating a practice case and project idea using the *Showing Evidence Tool*	15	81	23	73
Helped participants through the process of creating their own unit plan that integrates one or more of the online thinking tools	20	75	17	78

Participants also report that the pace of the training gave them ample time to learn how to use the tools. In response to the follow-up survey, 80% of Master Teachers reported that "the right amount of time" was dedicated to learning how to use the online thinking tools (n=191), and a large majority of those teachers who had used the tools in the classroom disagreed (53%) or strongly disagreed (34%) with the idea that they would need additional training in order to use the tools effectively with students. Even among Master Teachers who had not yet implemented their unit plans (n=90), only about one

in five teachers agreed (15.6%) or strongly agreed (5.6%) that they would need further training in order to use the tools with students.

Observational data reinforce these survey responses. Few teachers needed help or additional time to become familiar with the basic functions of the tools. Teachers' ability to learn to use the tools did not appear to be strongly related to their level of prior experience using technology in the classroom. Teachers with particularly low levels of technical knowledge occasionally asked questions about navigating through the tool workspaces, but all teachers were able to begin using the tools without significant challenges. While several workshops encountered delays due to technological problems (such as dropped Internet connections), typically these delays were brief and were minor impediments.

Participants' questions during periods of the workshop devoted to learning the features of the tools fell into two categories. Some were procedural: participants wanted to know, for example, how to log-on to a tool's workspace and how to ready the online area for a student lesson. Other procedural questions include:

- Will one password work for all three tools?
- How do I save my students' work in *Visual Ranking*?
- Can I mix "good" with "bad" evidence when populating bins in *Showing Evidence*?

Other questions pertained to the range and flexibility of the tools. For example, participants wanted to know exactly how extensive a tool's features were, and whether the tools could accommodate their ideas for student use. Examples of questions related to the range and flexibility of the tools include the following:

- Is it possible to enter one tool, such as *Visual Ranking*, in the teacher view, and then follow a link and be able to see all of the lessons I have developed for the other tools, such as *Showing Evidence*?
- I want to be able to move fluidly between the teacher and student views without having to log out and back up several screens through the system. Is there a way to do this? I need this flexibility as a Kindergarten teacher.

During the trainings and as teachers explored the tools, certain features were used more extensively than others. Typically teachers used features that would enable them to set up a unit or lesson, as well as those their students would use to enter information. Features used to support iterative use of the tools over time (such as teacher comments or the *Seeing Reason* portfolio) or the ability to access the tools from multiple locations were not discussed in detail, and were not referenced in unit plans collected during the evaluation. Only one trainer in the observed workshops discussed potential uses of the teacher comment box, saying, "Students like to see that you are paying attention." She suggested that offering teacher comments was one way a teacher could communicate to students that he or she had read what they had submitted and were interested in it.

Finding. *When the tools are first introduced, participants commonly raise concerns about their relevance to various grade levels and subject areas. Many of these concerns are resolved through the process of developing a unit plan. However, questions about the relevance of the tools for elementary-grade students and for mathematics and foreign language teaching persist through the conclusion of the workshop.*

In all of the observed trainings, participants raised questions early on about whether the online thinking tools were relevant or realistic for their curriculum and their students' needs. Participants' comments most frequently concerned whether they would be able to generate appropriate project ideas involving the tools.

Questions about the appropriateness of the tools for younger students were particularly common. Because participants' comments tended to be broad and brief, and few discussions of this issue were observed, it was difficult to discern whether these teachers felt the tools were too technically complicated for young students, or if they felt the concepts they tackled and the thinking they are intended to scaffold was too developmentally advanced for younger students. A few teachers, however, did articulate relatively specific concerns. For example, one Master Teacher expressed in the Follow-up Survey, "These tools seemed very difficult to use with the primary grades, and my

instructor was of little help when asked to help me plan and modify. I teach in an inclusion setting and a lot of the modifications I make to the curriculum and the way I present it uses visuals. There is no place for these visual models in these tools... I pointed this out to my instructor and my comments were dismissed as trivial." Likewise, several Senior Trainers, when reflecting on the tools' relevance in K-12 teaching and learning, noted that they thought the tools would be difficult to use with lower grades.

Participants, as well as the five of the Master Teachers who led observed workshops and several Senior Trainers, were particularly concerned about the relevance of *Showing Evidence* for the elementary grades, perceiving it to be the hardest to use, the most challenging to identify activities for, and the most difficult to integrate into instruction. As one Master Teacher commented in the Follow-up Survey, "I worked with a classroom teacher on a 5th-grade science project and we found it difficult to use *Showing Evidence* for that grade level." The other three observed trainers also addressed this concern, but encouraged participants to find a way to make the tool work with whatever grade level they taught. As one trainer assured his participants, "We will find ways to use the application so it makes sense in your classrooms." Another trainer chose to use teachers concerns as an opportunity. He framed his training as a "trial" and invited the participants to focus explicitly on the task of determining which tools were best for which grade levels.

Both Master and Participant Teachers working in mathematics and foreign languages also raised particularly pointed concerns about the tools' applicability in their classrooms. As a Master Teacher explained, "I found it very difficult to fit the tools into mathematics. I would have gained more if I could have brainstormed with other math teachers." Similarly, a foreign language participant said, "I have a hard time fitting the tools in with my subject area. I teach level 1 and 2 Spanish and at that low level they are working on basic skills and not higher order thinking skills. I thought I would get more ideas from this workshop instead of having to come up with all the ideas on my own." While these teachers typically expressed skepticism that the tools would ever be relevant to their core teaching, they said they were open to suggestions. They expressed their interest in

concrete guidance by asking for more, and more extensive examples and project ideas that addressed their particular discipline, as well as opportunities to spend more time collaborating and brainstorming with other participants.

Trainers provided a range of responses to these questions and observations about the tools' relevance, most often stressing the importance of building students' higher-order thinking skills and assuring teachers that these tools would help them improve their students' ability to draw on and express these skills. The depth and clarity of their presentation of these ideas varied significantly from trainer to trainer. Three trainers were able to communicate to their participants in succinct and compelling ways an image of the kind of thinking students could be helped to achieve. They did this by making connections between the skills the tools are intended to support and the teachers' existing priorities. For example, one trainer emphasized that specific critical thinking skills were included in their state standards and needed to be addressed in the classroom if students were to do well on state exams. The other five trainers either avoided responding to teachers' concerns directly, or re-stated explanations provided in the curriculum. Participants in these trainings were left to determine whether they could make useful connections between the tools and their own curriculum and teaching priorities.

Participants often found their concerns were addressed when, in the course of developing their units, they encountered examples, strategies and guidelines that illustrated for them exactly how the tools could be used various classroom settings. Participants particularly valued those elements of the curriculum and other available resources that provided practical suggestions for integrating the tools into specific subject areas and grade levels and that modeled what tool use would look like in a real classroom. Master Teacher participants indicated their interest in these kinds of resources on the Follow-up Survey, where they ranked the online thinking tools project ideas in the Appendix as "most helpful" more frequently than other resources, such as the individual learning taxonomy they created during the course of the workshops, or the Essential Questions examples, also provided in the Appendix.

Master Teachers' responses to the Follow-up survey also suggest that many teachers' initial concerns about curricular relevance are eventually addressed and resolved. Most respondents to that survey reported that the tools align with their state or local learning standards. Teachers who had used the tools with students before completing the survey were more likely to report this than those who had not. Ninety-three percent of Master Teachers (n=84) who had already used the tools either "disagreed" or "strongly disagreed" that "The tools do not align with standards and benchmarks in my subject area" versus 69% (n=62) of teachers who had not yet used them.

Finding: *Few trainers integrated discussion of the role of higher-order thinking skills in student learning throughout the workshop.*

In six of the eight observed Participant Teacher workshops, little time was devoted to participant discussion of how the tools could be used specifically to support student learning. In these workshops, trainers articulated the various questions provided in the curriculum materials, but did not follow up on teachers' responses and did not elaborate on the questions or pose any follow-up questions. In these cases, portions of the workshop devoted explicitly to student learning, such as the taxonomies of learning, were presented in isolation, and were not referred to again in later modules. Similarly, when teachers were developing their units, trainers did not comment on, or initiate discussions or demonstrations about, specific ways features of the tools could be used to facilitate specific steps in the learning process or to scaffold students' use of specific higher-order thinking skills.

In the remaining two workshops, however, participants did engage in robust but generalized conversations about student learning prompted by trainers' questions. For example, in one workshop a trainer asked, "As teachers, what do you have to do to learn how to use and incorporate these tools into the classroom?" Participants provided initial responses, which the trainer built on to develop a discussion. The group concluded it that would take time to learn how to integrate the tools into their

classrooms and that part of their job would be to identify on a case-by-case basis which tool might be useful to help them achieve particular learning goals. Similarly, in another workshop, while discussing the merits of pre-populating evidence versus having students search for evidence when using *Showing Evidence* the trainer sympathized with a participant's comment that, given time constraints, pre-populating the tool was probably a better option. The trainer then went on to encourage the teacher to view the tool in more flexible terms. He introduced the notion of "partial population," suggesting that the participant could provide some basic evidence and have students find additional pieces to support their particular arguments. This trainer referred back to this scenario again later in the workshop when discussing the issue of source validity.

In each of these workshops where sustained discussion took place, trainers introduced the idea of "differentiated instruction" and illustrated how different tools could be used to support different styles of learning. Participants found these illustrations particularly helpful; the trainers' examples gave them ideas for taking their students farther into a topic than they had previously attempted. For example, a Master Teacher described her unit plan in this way: "My unit was on the Civil War. The students were to learn about the Civil War in general, but during the Intel class I changed the unit from learning about the Civil War to actually analyzing what caused it, what happened, and eventually come to their own conclusion as to whether or not it SHOULD have happened."

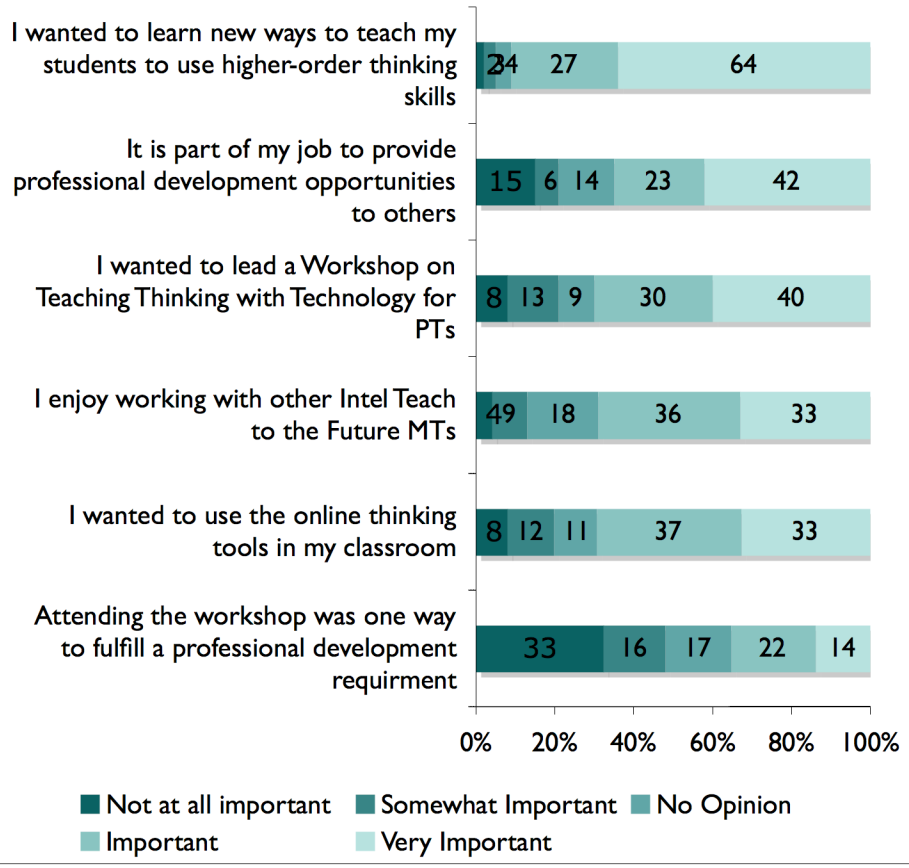
Both of the trainers who provoked substantive discussions of student learning found multiple opportunities to do two things the other trainers did not do: build on teachers' comments and questions constructively to pose new questions or suggest alternative perspectives, and weave repeated references to key ideas into the discussion throughout the span of the workshop. For example, these trainers seized the practical or logistical concerns teachers often raised by the midpoint of the workshops, such as how to rotate students on and off computers, how to break up their unit over several days, and what exactly to capture from the students' work within the tool workspaces for assessment or discussion purposes, as opportunities to discuss the larger learning goals supported by the tools.

In contrast, all other trainers presented material from the curriculum piece by piece and rarely added their own gloss to the curriculum, whether providing additional examples or anecdotes that would help to tie some of the more abstract material back to classroom practice, or pointing out connections and themes that run throughout the curriculum. For example, rather than making explicit connections between specific features or functions of the tools and opportunities to scaffold or focus student thinking, it was much more common for trainers to isolate their technical and procedural explanations of the tool from any discussion of the kinds of student learning the tools were intended to support. For example, one participant expressed that she was uncertain about how to set up a project and how to use the teacher comment feature available in *Visual Ranking*. The trainer addressed the technical question with ease, but did not extend his explanation to illustrate how the comment features could or should be used.

Finding. *Participants are motivated to use the tools to support student learning, but are not fully prepared to do so by the end of the workshop. Their use of and talk about the tools during the training suggests that they are oriented to, and prepared for using the tools in a project-based context and in connection with some kind of driving question, but that they do not explore in any depth how to use the tools to scaffold student use of specific thinking skills.*

According to responses to the Follow-up Survey, the most important reason the majority of Master Teachers were motivated to attend a workshop was the promise of learning new strategies to deepen student learning. Approximately two-thirds of respondents said "learning new ways to teach students to use higher-order thinking skills" was "very important" and one-third said it was "important." Additionally, as Figure 4 illustrates, participants' interest in higher-order thinking skills was notably greater than their interest in other reasons for attending the workshop listed in the survey.

Figure 4: Percentage of Teachers Who Indicated the Following Were Important Reasons for Participating in TTT Workshop (n=190)



Similarly, at the conclusion of the training, both Participant Teachers and Master Teachers were most likely to identify "connecting my curriculum with higher-order thinking skills" as a primary benefit they associated with using the tools (41.4% and 47.8%, respectively).

However, despite their interest in engaging students in higher-order thinking and using the tools to improve student learning, participant response to portions of the workshop explicitly addressing these issues were very mixed. Many teachers felt that they had "heard all this before," and either found the material to be unhelpful or overly familiar. Many teachers were also eager to move on to exploring the tools and found this discussion to be a poor use of their time. Teachers' relatively low level of interest in this

activity is also indicated by their responses to a survey question that asked respondents to consider what aspects of the workshop had helped them to prepare for using the tools in their classrooms. Both Participant Teachers and Master Teachers rated "exploring models for categorizing thinking skills" to be the least helpful aspect of the training (see Table 6).

Table 6: Proportion of participants who rated aspects of the trainings to be useful to them to "a great extent"

	Participant Teachers	Master Teachers
Exploring models for categorizing thinking skills	45.1	59.3
Discussing assessment	54.9	63.1
Practice with Curriculum Framing Questions	58.3	63.2
Creating curriculum-framing questions for my own classroom	58.3	64.4
Exploring how to encourage higher-order thinking in classroom	64.4	71.7
Observing Master Teacher's own instruction	60.2	72.5
Creating unit plan	62.2	73.6
Listening to Master Teacher explanations	64	73.8
Reflecting on my own practice	68.6	76.6
Curriculum guide, online resources	58.5	78.4
Creating a practice project	65.4	81.2
Collaborating with other Participant Teachers	71.3	81.4

Teacher reactions to this material during the workshop was very mixed. Most commonly, participants felt that since they were already familiar with Bloom's Taxonomy or other theories of student learning, the activities were superfluous and the participants should instead be allowed to "get on with it" and start learning about the online thinking tools that were the main attraction of the workshop. In some cases, participants found the taxonomies informative, but still expressed a preference for jumping directly into an exploration of the tools. Participants who previously had taken the Essential Course were particularly frustrated with the presentations of the taxonomies of learning. Referencing their positive earlier experience, these participants said they expected hands-on engagement with technology tools from the outset of the workshop and were frustrated that the workshop was a "slower" process. What was shared across each of these experiences, however, was an impatience with being "talked

at" and a desire to become more actively engaged in application of the tools and unit plan development earlier in the workshop.

Although this initial resistance to the structure of the workshop was observed uniformly, the workshops unfolded in two different ways. In four of the eight Participant Teacher workshops, as participants moved into the unit planning process, they were able to make connections between their own taxonomies and their developing unit plans. One Master Teacher who led such a workshop spoke very positively about the results of this process: "I am thoroughly excited about the prospect of using this workshop in our district. I feel it has the potential to impact the way our teachers design their units, and should encourage them to concentrate on merging the standards into projects that will truly generate some higher order thinking skills." This trainer and one other had made significant, persistent efforts to remind teachers to look back at their taxonomies during their unit planning process, and repeatedly posed questions and made comments that made links between more abstract images of the learning process and the units teachers were developing. In the other four trainings, however, there was little or no reference back to the learning taxonomies beyond a rote reference by the trainer once that module was concluded. Consequently, the majority of participants' work with the tools had few links to any explicit discussion of higher-order thinking skills or how to use the tools to diagnose and scaffold student learning. These participants experienced the different portions of the workshop as being isolated from one another and somewhat arbitrary in their content because they did not experience a set of coherent connections between one learning experience and the next.

Senior Trainers, in their own reflections on their training of Master Teachers, expressed some concerns that were consistent with the tensions observed in these workshops. Several Senior Trainers felt that their Master Teachers had not adequately grasped the idea that preparing teachers to support students' higher-order thinking skills is a fundamental goal of the workshop. They felt that some Master Teachers instead saw the taxonomies of learning as an "extra" that was peripheral to the core content of the

workshop and had not put enough effort into mastering the material or thinking through how it connected with the rest of the workshop content.

Both Master Teachers and Participant Teachers, despite the frustrations expressed over some of the workshop content, report leaving the workshop feeling that they are well prepared to use the tools to support students' critical thinking. At the conclusion of their trainings, a large majority of Master Teachers and Participants Teachers reported that they felt they were well prepared (24.1% for Participant Teachers, 30.3% for Master Teachers) or very well prepared (64.2% for Participant Teachers, 62.3% for Master Teachers) to "engage students in critical thinking about complex issues." This suggests that participants do remain interested in this dimension of tool use, have a sense of the types of real-world, complex topic the tools are well-suited to, and intend to use the tools to stimulate exploration of those topics by their students.

Finding: *Most participants are successfully creating unit plans that link use of the tools to their current classroom practice and that are broadly project-based in their structure. Participants primarily employ the tools to enhance their curriculum in two ways: making student thinking more visible, and stimulating group discussion. They are unlikely to focus specifically on engaging and building students' higher-order thinking skills.*

When developing a unit plan for use in their classroom, most workshop participants used features and functions of the tools that matched activities they were used to leading with their students. During workshop observations, teachers commonly referred to textbooks, rubrics, lesson plans, and curricular calendars they used in their existing practice to help them identify ways to integrate the tools into the kinds of lessons they were used to doing. In a typical example, a high school social studies teacher took a unit he had done in the past that focused on the presidency of Andrew Jackson, the displacement of native American groups, state vs. federal rights and voting rights and adapted it to accommodate *Visual Ranking* and *Showing Evidence*. He said he would use the first tool to rank the most important events of Jackson's presidency and encourage a discussion of how these events shaped the development of the country. He would use

the second tool to have students explore the U.S. government's removal of Native Americans from their homelands. Like many other teachers, he took activities he had already done many times with students and used the tools to enhance and make visible students' thinking about the topic at hand. Like many others, this lesson employed the tools' most basic function creating representations of information but the teachers' description and the lesson plan itself did not indicate that he planned to use other features of the tools, or specific strategies as a facilitator of the discussion, to push students toward more systematic or critical thinking about the evidence they were working with or the structure and strength of the arguments they were constructing.

Both trainers and participants showed a particular interest in the idea of "making student thinking visible." For example, when enumerating the advantages of the tools one trainer emphasized, "It makes students' thinking discussable." Similarly, another trainer announced, "These tools can act as a window into students' thinking," which he contrasted with a more traditional lecture approach where "you cannot look at students' thinking." A third trainer drew the connection between the notion of "visibility" and assessment. When one of the participants asked about the portfolio function within *Seeing Reason*, he said "It gives teachers a formative assessment tool. The map doesn't get the grade… it's a tool to map out students' thinking process."

In the sample set of unit plans gathered, almost all teachers planned to use one or more tools to make their students' thinking visible – to themselves or to their peers. Project descriptions and the procedures they outlined illustrated that teachers anticipate that using the tools will lead organically into students communicating with each other in meaningful small group conversations and/or large group discussions. For example, in the procedures section of one unit plan, a teacher who poses the Essential Question: "Are people equal?" describes the first activity on day two of the ten-week project, "Students will do the *Visual Ranking Tool* to rank the characteristics they look for in a person. After completing the activity in groups we will compare student group work and discuss the findings." In another project, addressing the question "How does academic success affect your future?" the teacher writes, "On day seven students will use the

seeing reason tool to explore factors that affect their level of success in their career. With their group they will then map these factors and discuss the relationships between them." As these representative examples show, teachers are not including in their unit plan documentation any questioning strategies that they plan to use to prompt student discussions or any focus or goals for the discussions, but instead, simply note that students' use of the tools will lead to sharing and communicating about similarities and differences among students' representations of their thinking.

Additionally, although teachers frequently express a general desire to use the tools to make thinking visible and to engage students in discussions, few unit plans focused explicitly on building students' "information and communication skills," which would indicate an intention to address the quality or strength of students' use and articulation of the information involved in the project. Only seven of the thirty unit plans identified developing students' information and communication skills as a foundation for building higher-order thinking skills in their "Habits of Learning Taxonomy."

Follow-up Survey results provide insight into how a subset of Master Teachers viewed their unit plans after the conclusion of their own training. Their reports are consistent with the evidence discussed above: in response to the Follow-up Survey, the most common objective Master Teachers said they had sought to address when they developed their unit plans was "To provide students the opportunity to visualize their thinking process through using the tools" (74%; n=194; see Table 7). This same question demonstrates that Master Teachers were particularly unlikely to be focused on building or enhancing their students' higher-order thinking skills when developing their units, as only 16.5% of respondents included it as a relevant objective even when they were invited to check all items that applied to their unit.

Table 7: Objectives Master Teachers sought to address in developing their unit plans (n=194)*

	Percent "Yes"
To provide students the opportunity to visualize their thinking process through using the tools.	73.7

To promote discussion in the classroom.	61.9
To encourage collaborative work among students.	66.5
To engage students in project-based learning activities.	64.9
To support the diverse needs of students (e.g. ELL, gifted, special needs).	38.1
To connect my curriculum with the higher-order thinking skills the tools are designed to support.	16.5
Other	25.8

* totals to more than 100% as respondents could check all that apply

Table 8 provides brief descriptions of representative unit plans, developed by Master Teachers, which are intended to use the tools to make students' thinking visible and to promote discussion.

Table 8: Sample Content of Master Teachers' Unit Plans

Grade Level	Subject	Tool	Description
Middle School	English/ Language Arts	*Visual Ranking*	Making Decisions — Use of the tool centered on a unit of study in my eighth-grade literature book that had stories about making decisions. I used the tool to have the students rank items from several of the stories as to what was the most important for making the decision that the main character made.
Upper Elementary	Social Studies/ History	*Visual Ranking*	Gone to Texas! — Students will take on the perspective of a settler of Texas and rank items to take with them on their wagon.
High School	Science	*Visual Ranking*	A Trip to the Moon — Through the use of the tool students were to rank which items were the most important items needed to have if stranded on the moon. Then, I had them compare them with what NASA said was important. The students were to explain their reasoning for the first, last and middle choices.
Middle School	English/ Language Arts	*Seeing Reason*	Ignorance is not Bliss! — We are consumers in everyday life. We buy what we need and what we want. Today you have the opportunity to look at the role of the advertiser. The goal of an advertiser is to influence the purchasing decisions of consumers. What are the influential factors available to the advertiser? Research the types of propaganda often used in advertising. Use the tool to explore all the variables of influence that might be used in advertising.
Middle School	English/ Language Arts	*Seeing Reason*	Eleanor Roosevelt for President? — Students read a biography of Eleanor Roosevelt in their reading book. They use the tool to map out factors that caused Eleanor to be shy/not shy during her childhood.
Upper Elementary	Social Studies/ History	*Seeing Reason*	Iditarod: the Last Great Race — Fifth-grade students in our District study the Iditarod. This unit will teach students about the race by focusing on why people take risks. There are many factors that affect whether or not a musher will complete the Iditarod. Students will brainstorm both positive and negative factors and show their impact on race completion.
Middle School	Math	*Showing Evidence*	Invest in the Future — Students will use the tool to argue and justify claims as to whether or not they should continue to invest in the stock market to meet future financial goals.
Upper Elementary	"Other" – World Geography	*Showing Evidence*	Around the World in 80 Days — Student teams research and plan a journey to each continent during their race. Prior to beginning the race, students will brainstorm as a class what makes different parts of the world unique and interesting. Student teams will use the tool to argue their position on whether increased tourism has a positive or negative impact on a nation's natural and human systems. Students will collect quality resources and evidence that both supports and weakens their argument, and use that information to assess whether they have a valid stance. Student teams will use this information to simulate a debate that might take place in a government agency when developing regulations about tourism.
Middle School	English/ Language Arts	*Showing Evidence*	Career Choices — Students will learn how they can use spreadsheets to evaluate choices. They will use the tool to explore the validity of perceptions about vocational education. They will interview community members and parents about career choices they made. Students then research two or three careers that meet the criteria they identified and determine the projected earnings and the costs of training needed.

***Finding**: Trainers often tailor or modify the workshop agenda to accommodate the interests and expectations of local participants or to accommodate logistical constraints.*

In all eight of the Participant Teacher workshops observed, trainers tailored their presentation of the workshop resources to teachers' local instructional interests. They did this in a variety of ways. For example, in at least one site, the trainer sought to recruit specific groups of teachers to participate. This trainer approached the program as a "pilot" and experimented with offering the workshop for specific groups, one consisting of high school teachers and one of elementary teachers. Another strategy was framing unit development during the workshop in terms of other local programs or priorities. One trainer used the workshop to meet the requirements of another grant-funded professional development program and gave participants the option of forming their own working groups based on grade level and school affiliation. Another trainer focused in on connections between the tools and the notion of differentiated learning activities throughout the workshop because this was an important goal for their school district.

Half of the trainers made modifications to accommodate local logistical practicalities. For example, half of the trainers adapted the training materials based on logistical needs of the districts, such as time constraints for letting teachers out of school, lack of substitute teachers to cover classes, and limited time available for professional development (e.g. during or after school, on weekends, or as part of in-service days). Trainers also did not always comply with the timeframes proscribed for the various workshop agenda formats (i.e. 24 hours for *Visual Ranking,* 32 hours for *Visual Ranking* and *Seeing Reason* or *Showing Evidence*, or 40 hours for all three tools). Instead these trainers made adaptations, such as fitting two tools into a one-tool agenda format, asking teachers to read components of the materials at home rather than having discussions face-to-face, or choosing to "streamline" the workshop by not providing multiple opportunities to refine project ideas and practice maps, lists, or cases over time.

The following examples provide more detail on two of the most substantial adaptations, both made by Master Teachers.

1. *Introducing the tools first*. In one rural site, the trainer, who is both a Senior Trainer and Master Teacher, has conducted previous Intel workshops for teachers. Because this trainer believes the technology tools to be a powerful motivation for teacher learning, he chose to involve teachers in hands-on manipulation of the tools at the very beginning of the workshop, making the tools themselves an entrée to the thinking models and questioning strategies. This trainer spoke about setting up the "hook" for the teachers, emphasizing the importance of putting "the concrete ahead of the abstract, of allowing participants to see the big picture and understand the tools before going into the theory and deeper thinking, so they have a sense of where they are going and where they hope to end up."

   In this same rural context, principals would not let teachers out for the full 40 hours required for a complete three-tool workshop. Rather than cancel the workshop or only offer a single tool, this experienced trainer adapted the available 24 hours (4 days at 6 hours each day) to encompass a two-tool workshop (*Visual Ranking* and *Seeing Reason*). This trainer felt comfortable doing this because he felt the curriculum was strong and could be "streamlined," a belief echoed by other local Senior Trainers and Master Teachers.
2. *Assimilating into a local agenda*. In a small southern city, the trainer is the district technology coordinator and an Intel Master Teacher. The district has made a long-term investment in staff development and instructional technology (staff have been given laptop computers, and are due to receive SMARTBoards for their classroom), and places a strong focus on teacher development of their own curricula. Consequently, this trainer has modified the workshop sequence and presents the workshop as an opportunity for teachers to begin incorporating the online thinking tools into the overall curriculum development plans of the district.

   The Master Teacher conducting the workshop used the first seven-and-a-half-hour workshop session to cover modules 1, 9, and 10 and engaged teachers quickly developing unit plans. In subsequent sessions, each three hours in duration, participants focused on the individual tools and integrated them into their units as appropriate.

2) How Participants Use the Tools in the Classroom

The findings presented in this sub-section are based on responses to the Master Teacher Follow-up Survey and classroom observations with five teachers. Each teacher was observed leading between one and five class sessions, for a total of fifteen individual classroom observations. During these classes three of the five teachers used *Visual Ranking* with their students, a fourth used *Seeing Reason*, and the fifth used *Showing Evidence*. See Table 3, above, for more detail on the classrooms observed.

Two of the five teachers are high school science teachers using the online tools to support physics learning, one is a middle school humanities teacher of gifted and talented students, and the remaining two are computer teachers observed using *Visual Ranking* with third graders. All five of the observed teachers are experienced educators, each with more than ten years of teaching experience. All five teachers allotted at least one entire class period to using one of the thinking tools, and in each case all students were actively involved in using the tools during the period. Additionally, three of the five teachers observed had been through the Master Teacher workshop, one had been through a Participant Teacher workshop, and one had not participated in a workshop, but had discussed and explored the tools with an experienced Senior Trainer who works in her building.

Finding: *Just over half of reporting Master Teachers (52.6%) have used the online thinking tools since participating in a workshop. Twice as many of these teachers report using Visual Ranking as report using Showing Evidence or Seeing Reason. The teachers most likely to report having used the tools are those who developed English/language arts units during their trainings and those teaching grades 9-12.*

Since attending the workshop, 43% of Master Teachers reported in the Follow-up Survey they had used the *Visual Ranking* tool with their students. Nineteen percent each had used *Seeing Reason* or *Showing Evidence*. Respondents who had previously taken the Essentials Course were somewhat more likely to have used the tools than those who had not taken the course. See Table 9 for details.

Master Teachers who developed English/language arts units, science units, or units covering other topics outside of the core content areas, such as technology and music or art, were more likely than others to have used the tools since the training. Those who developed units on music and art, foreign language, math, or computers and technology were less likely than others to have used the tools since the training. This is consistent with other findings described above, which suggest that math and foreign language teachers have a particularly difficult time finding ways to make the tools

relevant to their curriculum or their students' needs. Across this subject areas, roughly a third to a half of these teachers report only using Visual Ranking. This was most common among teachers who created units outside of these core content areas: nine of the twelve teachers in this group who reported using the tools since their training reported only using Visual Ranking. See Table 10.

Rates of tools use after training do not vary dramatically by grade level taught, but there is a trend toward more frequent tool use with the higher grades, and also toward use of a wider range of the tools. Only 50% of preK-5 teachers report using the tools since the training, and 28% (20 of 71 respondents) report only using Visual Ranking. This suggests that, at least among Master Teachers, preK-5 teachers are using the tools at slightly lower rates than teachers of higher grades and that much of their tool use is restricted to Visual Ranking. See Table 11.

Table 9: Percentage of Master Teachers Who Had Taken the Essentials Course and Used the Online Thinking Tools vs. Those Not Previously Trained (n=103)

	All Master Teachers	Trained in Essentials Course	Not Trained In Essentials Course
Visual Ranking Tool	43%	46%	35%
Seeing Reason Tool	19%	21%	14%
Showing Evidence Tool	19%	21%	15%

Table 10: Percentage of Master Teachers Who Have Used the Online Thinking Tools, by Unit Plan Content (n=101)

	Have used tools since training	Have only used Visual Ranking
Art/music (n=1)	0	0
Foreign language (n=5)	20% (1)	20% (1)
Math (n=15)	33% (5)	7% (1)
Computer/technology (n=33)	42% (14)	27% (9)
Social studies (n=50)	50% (25)	22% (11)
Science (n=32)	59% (19)	16% (5)
Other (n=20)	60% (12)	45% (9)
English/language arts (n=38)	66% (13)	29% (11)

Table 11: Percentage of Master Teachers Who Have Used the Online Thinking Tools, by Grade Level (n=103)

	Have used tools since training	Have only used Visual Ranking
preK – 5 (n=71)	50% (35)	28% (20)
Grades 6-8 (n=69)	54% (37)	25% (17)
Grades 9-12 (n=56)	55% (31)	20% (11)

***Finding**: The online thinking tools work smoothly in classrooms with adequate technical infrastructure, and students learn to use them easily.*

Responses to the Follow-up Survey do not indicate significant technical or logistical obstacles to using the tools, with one exception. Gaining access to computers and the Internet that could support students' work with the tools was a barrier for a significant portion of the respondents. Specifically, 38% felt that it was difficult to schedule time in school computer labs that was needed to use the online thinking tools with students, and 25.5% felt their school either did not have adequate hardware or did not have a robust enough Internet connection to support the use of the tools. Other potential barriers to use were not viewed as significant by respondents. Very few felt they needed more technical (7%) or administrative (8%) support in order to use the tools with students. Most (82%) believed their students had adequate computer or Internet skills to navigate and manage the tools, and only 3% reported that their students did not find the tools easy to use. See Table 10 for details.

Table 10: Percentage of Master Teachers who agreed or agreed strongly that they encountered specific challenges when using the online thinking tools in the classroom (n=101)

	Strongly agree	Agree
It is not easy to schedule adequate computer or Internet access for students to use the tools (i.e. scheduling computer lab access)	10	28
My school does not have adequate computer or Internet resources for students to use the tools	5.1	20.4
My students do not have strong enough computer or Internet skills to use the tools effectively	1.0	10.9
I did not have adequate technical support to use the tools.	5.0	2.0
I would need more administrative support to use the tools.	2.9	5.9

Classroom observations were consistent with these findings, with the exception that the teachers involved all had easy access to many up-to-date computers and robust Internet connections. The teachers and students who participated in the 15 observed lessons used the tools with ease and comfort. Students in the observed classrooms had more than adequate technical skills to use the tools. They were able to log in and out of the Student Workspace, use the individual tools, and perform the procedural dimensions of

tasks their teachers had asked them to do with little or no difficulty. In each of the classes observed, students spent very little time learning how to use the tools and focused almost all of their on-computer time on the substance of the lessons. The clarifying questions they asked to their teachers and to one another, when they were arranged in teams, pertained almost entirely to the substance of their assignments, not the technical workings of the tools. For example, during a fifteen minute small-group Visual Ranking activity (which was the students' first hands-on encounter with the tool), all the questions asked by middle school students in one class were about the vocabulary the teacher had used when populating the initial list they were working with, which included words such as "infrastructure" and "equitable."

During classroom observations, neither teachers nor students encountered any significant technical barriers. Minor barriers, such as printouts from *Visual Ranking* that cut off the ends of lines of text, may have been rooted in settings on local computers, or were the result of mix-ups or mistakes made in the classroom. Students were consistently able to make use of the tools' various functions as the teachers asked them to, and frequently moved ahead to use additional functions before they had been invited to do so by their teachers. For instance, in two classrooms using *Visual Ranking*, students discovered and used the "compare lists" function after their teacher had mentioned it, but before the teacher had explained it or invited them to use it.

Observed classes took place in computer labs or classrooms that were outfitted with at least two dozen computers each. In each case there were more computers than there were students in the class. All five teachers observed in the classroom— three classroom teachers and two computer technology teachers — were familiar with technology and had integrated computer-based lessons into their teaching prior to their use of the online thinking tools. Three teachers used a SMARTBoard and a projector in the course of observed lessons to focus students on a demonstration of specific features of the tools, beginning from the Teacher Workspace they had set up during the workshop. One teacher also used software that enabled him to control the students' computers, and used this software to display and discuss the artifacts students were

creating. The other teachers introduced the tools in similar ways but simply had their relatively small classes (as small as seven students) stand around him or her as she demonstrated on a single computer.

Teachers expected all students in a class to use the online thinking tools at the same time, sometimes assigning students to small groups and sometimes asking them to work individually. Simultaneous use of the tools was a priority for these teachers because they had created units in which using the tool was a specific step in a clearly defined process that had been laid out by the teacher as the backbone of a project. Because of this expectation, four of the five teachers whose classes were observed needed to conduct their lessons in their school's computer lab in order to provide students with adequate access to the online thinking tools. The fifth teacher had adequate technology resources in her classroom to allow her to accomplish her unit's objectives.

All five teachers used advanced features of the tools during their lessons, features that received little attention during observed workshops (see above). For example, each application of *Visual Ranking* involved the use of comment boxes and multiple classes used the comparison functions to compare and contrast students' lists. Similarly, the class that used *Seeing Reason* made use of the portfolio function, a feature that was not referenced in any other collected lesson plans or discussed in any detail during workshops.

Finding: *The tools are consistently used to support documentation of students' thinking, comparison of results, and discussion of ideas. They are not typically used to support sustained collection of evidence, rigorous evaluation of evidence, or drawing conclusions about the validity or strength of hypotheses or conclusions.*

Classroom observations, review of sample lesson plans, and responses to the Follow-Up Survey all indicate that teachers use the online thinking tools in a project-based context, although the scope and depth of the project varies widely. The tools are frequently used to address real-world problems, although humanities and social studies teachers in

particular also use the tools to support the examination of relationships within fictional or generalized systems or groups (such as characters in a novel, or "features of an ideal society"). Teachers emphasize the idea of using the tool to represent a particular perspective on an issue, sometimes assigning students to take on a specific role and sometimes inviting students to choose for themselves whether to present their own perspective or to take on a relevant role. Projects and activities typically provided significant structure for students, guiding them step-by-step through a process, but invited student to construct unique responses to the driving prompt or question.

Both observed classes and sample lesson plans suggest that while teachers often include the collection and presentation of evidence as a part of a project that involves the tools, this portion of the activity is not typically emphasized. For example, in observed classrooms teachers did not spend a significant amount of time discussing the process of selecting or evaluating evidence to include in the tool space. Additionally, in none of the observed classes or the sample lesson plans was the collection of evidence tied to any larger inquiry process beyond populating the student space within a given tool. Teachers instead placed their emphasis on the idea that students should construct and present a perspective or a belief, and then share their representation and compare it with others.

Finding: *All of the observed teachers are highly experienced, have unusually high levels of autonomy in their teaching, and have easy access to better-than-average technology.*

All of the five observed teachers work in conditions that provide them with resources that support and even encourage experimentation and innovation in their teaching. Three of the five create their own curriculum with few or no constraints, and the remaining two are established science teachers who know how and when they can adapt their curriculum while covering required material on schedule. All of these teachers were working with classrooms of twenty students or less, and reported no obstacles in getting access to the computers they needed in order to use the tools with their students.

Examples of classroom use of the tools

The following examples provide illustrations of classroom use of the tools. Each of these classroom activities exhibits many strengths as well as some missed opportunities. Each provides glimpses both of what is possible when using the tools with students and the challenges involved.

High school physics: Seeing Reason

In a high school class, a Survey of Physics, a class of twelve tenth-grade students was observed working in groups of three to think about and visualize the factors that influence petroleum use using *Seeing Reason*. Prior to this class students had explored related issues and created related PowerPoint presentations, and in the course of the whole unit the teacher planned to have students use all three online thinking tools. This unit was the one the teacher had developed at the workshop, and was framed by an overarching Essential Question. This teacher had been through the Essentials Course as well as the workshop.

The teacher introduces the tool using an overhead projector. His initial explanation of the tool is read off of the website. He then moves through the tool demo at the website, and emphasizes that "the beauty of the tool" is that he can revise the relationships he creates as he goes along, and that "the power of the tool" is that a user can provide explanations of or evidence for particular relationships. After he has brainstormed several factors in the demo, a student asks, "Can we access this from home?" The teacher says yes, and goes on to note the portfolio function, saying "It sort of locks it in and I can go in and take a look at it. And, then you can go in and make changes and save it again. You can always add and subtract to it as your understanding changes. I didn't think of all of the factors in a single sitting and I don't expect you to be able to either."

The teacher introduces the specific activity for the day by asking students to move to the project folder he has created and reading the driving question out loud: "What factors will influence how quickly we reduce our demand for petroleum as a fuel?"

Students begin to work by brainstorming factors, and the teacher then prompts them to begin to think about increase/decrease relationships. He also encourages students to think of factors outside of the automotive industry, where all of the students have concentrated their work so far.

As the period ends, a student is concerned that the teacher will be looking at their maps, saying "But we're not done." The teacher says, "It's good for me to see your progress and where you got in one day. We'll return to this again." He reminds the students that the tool allows them to track their thinking over time.

This teacher noted that he was devoting more class time to this topic than usual, because of the introduction of the online thinking tool. While normally the class would cover the topic over ten to 12 class periods, they would now be spending up to 22 class periods on the topic. This meant that the class would be skipping the next topic in the curriculum (waves). While the teacher had been eager to try out the tools with students, he expressed concern about this curricular tradeoff.

Middle School Gifted and Talented Class: Visual Ranking

A middle school gifted and talented teacher used *Visual Ranking* to support a two-day activity that was one step in a semester-long inquiry into the question, "What constitutes an ideal society?" The class includes eleven eighth graders, who have recently used *Showing Evidence* in her class. She begins her introduction of *Visual Ranking* by asking, "What does it mean to rank something?" Students volunteer that it means to grade or to judge. She acknowledges these responses and says that the tool is for "rank ordering things it's about order, putting things in some kind of order."

The teacher begins the activity by referencing a specific aspect of their overarching Essential Question, which they have been discussing recently in relation to a novel about a dystopian society: What makes a society successful? She distinguishes "ideal" from "successful" and notes that a society can thrive without having qualities that "we" might consider great or good. She then introduces the specific task for the day, which is to

rank order a list of factors (which she has pre-populated in *Visual Ranking*) that may contribute to a society's ability to thrive, and to provide a rationale for their decisions. She defines a rationale by saying, "tell why you put that piece where it is. Why do you think x is more important than y?" She encourages them to cite very specific reasons and to provide specific references to the text of the novel or their world history textbooks. She notes that they can base their judgments on the society presented in the novel, on their own lives, or on societies they have studied recently in their social studies class. She then briefly introduces the compare function and the correlation function, and breaks the class up into four small teams.

For approximately twenty minutes, students work within their teams, moving items around on the list and adding rationales for each item as they rank it. Students within teams seek consensus on the placement of items. A few of the items on the list (such as "contact with other societies" and "equal treatment for all under the law") are directly relevant to the novel they have just read, and some students' comments on these items reference the society depicted in the novel. Most rationales, however, reference students' lived experience and general knowledge. For example, all students rank "education for all" and "high quality medical care" near the top of their lists, and their rationales are variations on the idea that "without these things, everything will fall apart." "High quality recreational facilities" are put at the bottom of the list by one team with the comment, "they aren't important because we don't go anyway. Not to the ones around here." Although student discussion rarely makes explicit reference to the distinction the teacher posed between "successful" and "good" societies, students tend to place items they associate with sustainability closer to the top of the list, while items associated with personal freedoms or equality are put further down the list.

For the final fifteen minutes of the period students spontaneously begin using the "compare" function and note the wide variation in their rankings. As students begin to compare their lists the teacher gives some prompts to the group: "Who are you close to? Who are you far apart from? Look at their rationales, see if you can come to terms with each other." Students do not reference the correlation figures. Informal cross-talk

arises among students as they challenge each other's lists, with comments such as, "How can you not say that food is most important? Without that, you'll last about a week." Students' discussions reflect their desire to "convert" one another to their perspective, but no consensus emerges.

As the period concludes, the teacher prompts them to save their lists. She asks some follow-up questions: "Who did you compare with? Did you make any changes based on what you saw and read?" but does not try to start a group discussion as the period is almost over. They will have a follow up writing assignment the following week, in which they will reflect on the process of creating the list and note whether and how they were influenced by others' thinking.

Elementary School Computer Class: Visual Ranking

In a third-grade elementary school, a computer teacher prepared a three-day lesson (broken into two parts) that used the *Visual Ranking Tool.* This lesson was based on a version of the unit the teacher developed during the workshop, although it did not have an overarching Essential Question. During part one of the project, students were asked to work independently to rank and describe the personal attributes that best described themselves and compare their responses to others. During this first activity, students were not aware of the second part of the project, during which the teacher planned to have students work in pairs (off-line) and as a whole class (on-line) to reach consensus about which qualities that they would like or look for in a friend.

The computer teacher arranged for students to complete the third day of the project with their classroom teachers by taking the descriptive phrases generated in the comments section of the *Visual Ranking Tool* during computer class and turning these into full sentences and paragraphs about themselves. Students would then receive a grade on this piece of writing. Two classes were observed with the computer teacher introducing the project and the tool, and three classes were observed in which students continued to refine their *Visual Ranking* lists and comment descriptions and used the comparison feature of the tool.

In one computer class, eighteen third-graders worked on the second day of the project, led by their computer teacher. A classroom teacher was in the room observing because the computer teacher was using this lesson to model technology integration for the classroom teacher. After students were seated, the computer teacher spent about five minutes reviewing the first day of the project. She says, "Last week we discussed different attributes about ourselves," and asks prompting questions about how to access the Internet and the *Visual Ranking Tool*. As students respond, she models the steps using a computer connected to a projector. She then asks students to work independently on their computers to do what she has just modeled for them.

While students are working, she sits with one student who is new to the class and provides a quick introduction to the project. She shows her the list of attributes (e.g. kind, smart, creative, athletic) presented in alphabetical order and asks, "What most describes you and what least describes you?" She demonstrates some technical skills, such as making the workspace bigger by dragging the corner of the screen. She shows the student how to drag and drop the list items to rank them, explaining, "If you are not artistic then you will drag this to the bottom – you will put these in order from the most to the least." She leaves the student to work and attends to the others to see if they need help.

Other students are working independently, concentrating on refining their lists, moving the list items up and down and typing descriptions in the comment boxes. Almost all of their comments are in the format of "… because I like to…." Very little discussion occurs other than students asking questions about definitions or how to spell words. New words are added to the "word wall" projected on the wall with the overhead. Students work at their own paces during the 43-minute period. The teacher returns her attention back to the new student. She shows her how to write in comments by clicking on the list items, and explains that she doesn't want her to write in complete sentences, but phrases like "… because" and points to an example on a poster hanging on the wall.

She prompts the student to think about, "What do you do that proves you are kind or what has someone said that proves you are kind?"

Two students complete their task and the teacher shows them how to use the *Visual Ranking* print button and demonstrates how to use the compare feature to compare their lists to each other and to her list. She says, "Look, you both have very different personalities," pointing out that one student has "Athletic" first and the other has "Kind." She asks them to "look at all of the teams and see who is closest to you." The students are able to use the comparison feature of the tool to look at the different teams' lists, but do not comment on the ranking of the listed features and make no comments directly comparing the placement of features on different lists. After the class ends, the teacher comments that she feels she should have listed fewer attributes, and that she does not think the students fully understood what it meant to rank the items, or how their comments should differ across items ranked relatively higher or lower on the list.

V. Discussion

The Workshops on Teaching Thinking with Technology seek to address an ambitious set of goals. They are designed to influence teacher practice, generate new ideas for deepening learning within existing curriculum, introduce a relatively unusual class of software tools into classrooms, and prepare the broadest possible spectrum of teachers to integrate these tools into project-based learning in their classrooms.

The broadest and first objective statement presented in the workshop curriculum is the following: "Workshop participants [will] learn instructional strategies for addressing and assessing thinking skills using technology to increase opportunities for effective student collaboration, student teacher interactions, and the inquiry process." This evaluation suggests that the workshops are meeting many of the elements of this objective. Although there is undoubtedly variation in teachers' level of enthusiasm for and readiness to use the tools, participants find the tools easy to use and innovative, and many participants find them to be relevant to a topic of concern to them. Participants value the tools as a mechanism to provoke students to use higher-order thinking skills, and to prompt discussion in the classroom.

At the same time, evidence of teacher follow-up to the workshop is mixed, and there are real questions to consider about how deep or sustained the impact of exposure to this workshop will be on teachers' practice. Evidence of teacher follow-up to their workshop experience suggests that many teachers go on to use *Visual Ranking* with their students, and that a substantial minority are using *Seeing Reason* and *Showing Evidence* as well. Review of sample unit plans, discussions with teachers, and classroom observation demonstrate that teachers' follow-up use of the tools includes key features the program seeks to encourage: providing a project-based context for use, asking students to provide rationales for their choices, and stimulating discussion. However, teacher questions about the relevance of the tools to their curriculum, particularly in the early grades (which are heavily represented among program participants), raise questions about whether a significant number of teachers will be likely to implement similar lessons, or return to the tools, repeatedly over time.

Regarding the tools' potential to support and stimulate students' use of higher-order thinking skills, the findings of this evaluation suggest that the challenge that remains is to better prepare teachers to sharpen and deepen their focus on using the tools to structure and enhance students' critical examination of their own and others' thinking and reasoning. The workshops are already generating substantial teacher enthusiasm for "making thinking visible" and for provoking lively discussion in the classroom, two crucial features of a project-driven classroom in which students are building a deep understanding of content and routinely practicing and refining their critical thinking skills. However, both participants' experiences in the workshop and their follow-up activities indicate that the workshop is not yet adequately preparing them to guide their students through the equally important stages of defining good questions, setting criteria and procedures for gathering evidence, and evaluating and presenting evidence both accurately and convincingly, and in particular is not directing them toward using specific features and functions of the online thinking tools to support these activities.

Returning to Pea's (2004) distinction between social scaffolding and technological scaffolding, the workshops seem to be familiarizing teachers with the features of appropriate social scaffolding to support student learning and the development of higher-order thinking skills, but are not exposing teachers to enough detailed exploration of how to deploy the available technological scaffolding to stimulate and extend students' use of specific higher-order thinking skills. For example, the emphasis many participants place on encouraging in-class discussion of the artifacts students create using the tools is an example of a social scaffold: the teachers are taking specific actions to create learning environments in which knowledge is explicit, shared, and discussed. But this evaluation uncovered little evidence that teachers are using, or are learning to use, the available technological scaffolding: those features of the online thinking tools that can stimulate students to reflect on, revise, challenge or improve the structures and content of those representations and, by extension, improve their own ideas, knowledge, and argumentation. For example, few teachers built time for multiple rounds of evidence collection and revision of artifacts into their units, which means that

students are unlikely to have reason to look critically at their own original representations of their ideas and to try to modify them to reflect a more rigorous argument or a better accounting of the available evidence. Without more deliberate and carefully designed deployment of the tools in follow-up classroom activities, use of the online thinking tools is unlikely to have an impact on students' mastery of either content or the higher-order thinking skills these workshops seek to support.

Observations of the workshops provide a clear explanation of why program participants are not yet adequately focused on or able to support these elements of project-based teaching and learning. As noted above, the majority of workshops observed were striking in their limited use of discussion or group work. Instead, these workshops were dominated by lecture and independent computer-based work by participants as their primary instructional strategies. The amount of time spent in these workshops on the delivery of information from the trainer to the teachers, in particular, is inconsistent with current research on how people learn (Bransford, Brown, and Cocking, 2000), on how outstanding teachers teach (Darling-Hammond and Sykes, 1999; Shulman, 2004), and with the model of instruction being promoted by the workshop itself. When teachers spend their professional development time listening passively and working independently, they are unlikely to master the substantive and challenging content the workshops seek to cover. Instead, teachers are likely to absorb some information and acquire technical skills, and to then draw conclusions independently, and based on their prior expertise, about how to connect this material to their existing practice.

By contrast, the challenging task of teaching teachers how to lead students in the early stages of project work with these tools will require engaging teachers in much more active learning, particularly structured reflection on their current practice and examination of artifacts of student learning (including those they produce themselves). These approaches are needed to allow teachers to move beyond using visual representations of student thinking to stimulate discussion in general, toward stimulating discussion that requires students to analyze, critique, compare and defend the ideas the online thinking tools have helped them to develop. This approach could be built into the

core activities of the curriculum, or it could depend on more extensively preparing trainers to stimulate and lead locally grounded discussions based on the core ideas presented in the curriculum, or some combination of these two approaches.

Many teachers are leaving the workshops interested in the tools, engaged with the idea of making their students' thinking visible, and motivated to use technology in a project-based context in their classrooms. But if the workshops are intended to achieve a more substantive shift in teachers' knowledge and practice of supporting student inquiry, the workshops will need to move away from the delivery of information and toward supporting teachers' own inquiry into how they, and their students, can build knowledge through the use of these tools.

VI. Recommendations

Based on the findings described above, the following recommendations are presented with a goal of further strengthening the program's ability to achieve its objectives by preparing and motivating teachers to provide the social scaffolds and exploit the technological scaffolds that can best support the development of their students' higher-order thinking skills.

Communicate early and often that these tools provide a window into students' thinking. The idea that the online thinking tools make students' thinking visible was the most broadly recognized and most enthusiastically received perspective on the relevance of the tools to everyday classroom practice. Teachers are eager to find ways to draw their students out, to get them talking, and to gain access to their thinking to learn more about what they do and don't understand. Stimulating discussion about teachers' current practices, when and why they would want this kind of insight into student thinking, and the obstacles they encounter with their current strategies, would all contribute to building a strong link between teachers' existing professional interests and priorities and the promise of the online thinking tools.

Engage teachers in discussions of student work in core content areas. Replace trainer-driven instructional time during the workshop with discussions and team activities that invite teachers to unpack examples of each stage of development of a student project. These could be spread across the various tools, because common issues, such as defining good questions, relating evidence to claims, and providing justifications for choices are common across all three tools. These discussions would provide opportunities to address issues including what can and can't be learned about students' thinking from a given artifact created with one of the tools, how to define a task that will make visible and maximize students' thinking, and how to use the evidence presented in a map as a diagnostic assessment tool.

Prepare trainers to discuss how the features of the tools scaffold specific components of the learning process. Activities such as connecting comments to

factors in *Seeing Reason*, using the teacher comment function in any of the tools, or ranking evidence in *Showing Evidence* can play powerful roles in stimulating students to think systematically and rigorously about topics such as the relationships among ideas, how evidence relates to argumentation, and how to not just coordinate tasks but truly collaborate when students work in groups. Trainers need to be prepared and prompted to draw teachers beyond learning to use the tools procedurally and into an exploration of specific tool features as supports to student learning.

Address the practicalities of classroom implementation of the tools and associated units or projects in more detail. Teachers who are not already experienced classroom technology users need more guidance during the workshop to ensure that they feel prepared enough to make the leap to experimenting with the tools in the classroom. In addition to addressing issues such as classroom management in the unit planning process, the details of implementation and realities of classroom context can be illustrated and discussed in examples to provide teachers with a broader vision of what projects involving the tools can look like in practice in classrooms like their own.

Address the needs and concerns of K-5 teachers. If the workshops are truly intended for a K-12 audience, a significant effort needs to be made to develop more examples of how the tools can be integrated into an elementary-grade classroom. Some of these examples need to be featured in the workshop itself, and trainers need to be prepared to address the needs of this large group of teachers. Additionally, if elementary-grade project examples are qualitatively different from upper-grade projects (for example, if *Showing Evidence* project examples do not involve students in ranking evidence against set criteria), these differences need to be addressed explicitly and the developmental concerns underlying those modifications need to be discussed.

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