The Technology Literacy Inventory:
Assessing Teacher Candidates' Readiness to Teach All Students

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Abstract

As technology learning by teacher candidates moves outside the college walls and into K-12 schools, how do we track and assess it? This paper presents the results of an exploratory effort to track and assess teacher candidates' technology learning using online, case-like scenarios designed to elicit their thinking about technologies as tools for teaching all students well. The Technology Literacy Inventory (TLI) invites users to make recommendations to a fictional colleague who needs to decide whether and how to enhance a lesson with technology. TLI results for teacher candidates and cooperating teachers are presented and discussed, as are a range of practical challenges that arise in designing and implementing online assessments that use case-like scenarios.

Introduction

Preservice teachers say that despite what they learn in college settings, they still lack understanding of effective technology use in contemporary classrooms (Balli, Wright, & Foster, 1997). At Bank Street College of Education in New York City, instructional technologists and researchers have found what others have found – that there are limits to the learning that occurs for candidates when the approach is simply integrating technologies into teacher education courses (Cohen & Tally, 2004; Willis, 1997). Bank Street's Project ConTEXT has worked with cooperating teachers in six New York City public and private schools to create technology-rich field placements for its teacher candidates, guided by the notion that well-coordinated school-university collaborations can have powerful reciprocal effects on the quality of teaching in both settings (Hartshorne, Ferdig & Dawson, 2004). In these collaborations, cooperating teachers (called *clinical faculty* at Bank Street), university instructional technologists and teacher candidates strive to integrate technologies into classroom teaching as part of semester-long action-research projects. Assessing the technology learning that occurs for candidates in these settings is a challenge that few existing assessments can help address, since most current assessments of technology learning fall into two categories: rubrics and check-lists that rely on self-assessment (e.g., NCRTEC, 1997); and inventories of skills with specific tools and applications (e.g., USOE, 1995).

In order to understand the impact that field experiences were having on teacher candidates' preparation to teach with technology, EDC researchers and designers created a web-based instrument called the Technology Literacy Inventory (TLI). The inventory is a 20-minute online exercise that asks teacher candidates to aid a fictional colleague by proposing technology enhancements to one of the colleague's lessons. The lessons contained in the instrument were adapted from those highlighted in the ISTE's NETS

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Standards for Teachers (ISTE, 2001). The online exercise is typically distributed via e-mailings to all participating students, other graduate students, as well as the clinical faculty, and small incentives are offered for completion.

Creating the TLI

In keeping with Bank Street's emphasis on adapting teaching to the needs of individual students, the TLI invites candidates to describe how the technology-based lesson enhancements they propose will benefit different types of students. Students taking the Inventory are given a hypothetical colleague's sample lesson (Figures 1 and 2) and asked to decide which steps in the lesson procedure should be modified with technology, how, and for whose benefit (Figure 3).

To do this well, candidates must consider the goals of the colleague's lesson, the different kinds of students in the class, and a range of possible technology enhancements (e.g. the Web, Inspiration, PowerPoint, digital cameras, subject- or skill-specific software) that might or might not address student needs. (If they would like they can see a brief profile of the students in the hypothetical class.) Users' input – their 'advice' to the colleague about how to use technology – is saved and stored as performance data. The sample lessons presented in the Inventory were derived from the ISTE's model lessons, but the technology uses were carefully stripped out, so that teacher candidates had to imagine the technologies that might be most appropriate to enhancing any particular procedure of the lesson, and supply reasons or rationales for their choices. The TLI can be viewed at: http://www.edc.org/CCT/tech_lit.

Administering the TLI

Our original research design called for administering pre- and post-tests of the TLI to matched groups of teachers candidates – those who were placed in ConTEXT's 'technology rich' classrooms, and those who were placed in regular, non-ConTEXT classrooms. We reasoned that since students placed in ConTEXT classrooms would be observing, participating in and reflecting on technology uses modeled by ConTEXT-trained clinical faculty, they might thereby be better prepared to think well about technology choices (as reflected in the TLI) than peers placed in classrooms where clinical faculty had not benefited from ConTEXT training and support.

Several circumstances made this logic model unworkable, and necessitated a shift in research activities. First, interviews with clinical faculty revealed that in over half of the Context classrooms individual graduate students actually had scant exposure to technology-based teaching in the timeframe of their single 6 to 10 week placement. ConTEXT clinical faculty were indeed teaching with technologies in small and occasionally large ways, but the duration, intensity and visibility of this work was such that student teachers who were with them for a single 6-, 8-, or 10-week field placement might not pay particular attention to it.i At the same time, questionnaires of graduate

Figure 1. Sample TLI Screen – Introduction

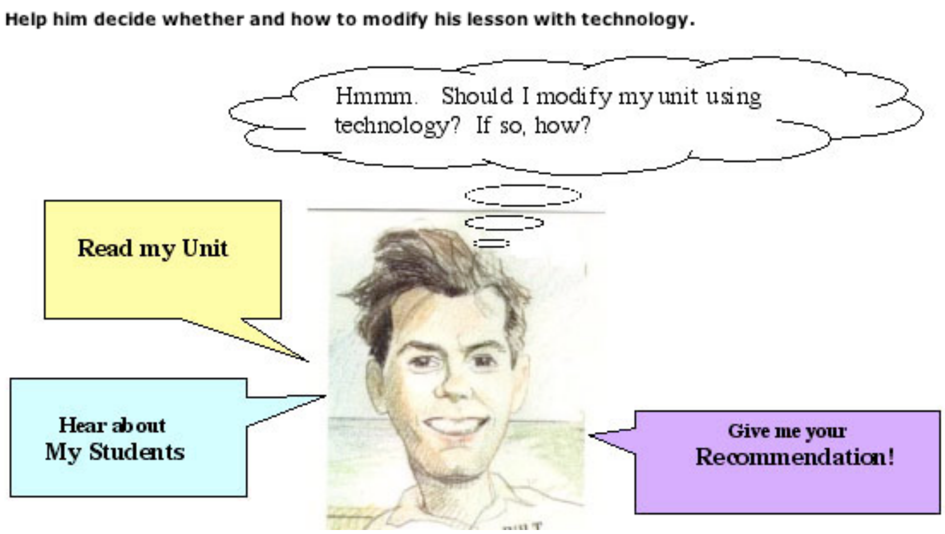


Figure 2. Sample TLI Screen – Lesson procedure

"Navigating By Landmarks" P R O C E D U R E

1. Discuss ways that people find their way from one place to another. Brainstorm a list of landmarks students use to guide them to and from school.

   Should I enhance **this** step with technology? ○ Yes ○ No

2. For homework, have students record each landmark they pass on the trip to school and what they do when they get to it. In class have students create written directions from their notes.

   Should I enhance **this** step with technology? ○ Yes ○ No

Figure 3. Sample TLI Screen – Type of user input collected

1. Discuss ways that people find their way from one place to another. Brainstorm a list of landmarks students use to guide them to and from school.

   Should I enhance **this** step with technology? ◉ Yes ○ No

If yes, what kind?	If yes or no, *why*?	If yes, what *students* will this help? How? (Hear about my students)
MapQuest or GoogleMaps-- kids could find and print their route from home to school.	It would be a 2-D map, to complement their home-made maps.	I'm not sure....
Note: Clicking 'Back' may cause you to lose any text you have entered.		CLOSE

students revealed that many were experiencing technology in other, non-ConTEXT placements as well as graduate classrooms. Thus comparing ConTEXT and non-ConTEXT cohorts was not warranted, because the intervention – creating technology-rich field placements – was not at a sufficient stage of maturity and stability.

Another reason that a matched comparison-group strategy was not advisable at this stage was that the TLI itself was not sufficiently mature as a data-gathering tool. Software bugs had to be worked through, we had to work around unanticipated difficulties in getting students to take the inventory, and routines for analyzing and validating the resulting data needed to be developed and perfected.

Accordingly, researchers shifted to a strategy that entailed: a) administering the TLI to a more diverse set of BSC teacher candidates; b) analyzing the responses diagnostically – i.e., looking to see where students in different parts of the program are scoring high, and where they are scoring low; and c) looking for correlations among students' prior technology experiences and higher scores on the Inventory. We deemed this series of pilot implementations of the TLI most appropriate for providing useful performance information to guide decisions about the direction of the programmatic work.

Validating the TLI

Researchers developed a rubric for scoring user responses. The TLI Scoring Rubric (see Appendix A) coded each of the user's five or six possible lesson enhancements along the following five dimensions:

1) Evidence of familiarity with specific technology applications;
2) Presence of a sound pedagogical rationale;
3) Citing specific students or student needs being addressed by technology;
4) Citing classroom management realities or challenges;
5) Thinking critically about technology uses.

For example, a recommended technology enhancement might be considered to include evidence of familiarity with the particular technology application if it included specific details of the application's features, or differentiated uses of the application. A pedagogical rationale was deemed present when the user plausibly linked the application being recommended to one or more of the goals of the activity. (See Appendix A for the full list of criteria.) Inter-rater reliability in scoring was established through comparison of repeated blind scores of two reviewers. Adjustments were made to several criteria to achieve a better, more reliable fit. We validated our rubric by comparing the TLI scores of clinical faculty to independent assessments of technology literacy based on interviews and classroom observations.

Results of TLI Assessments

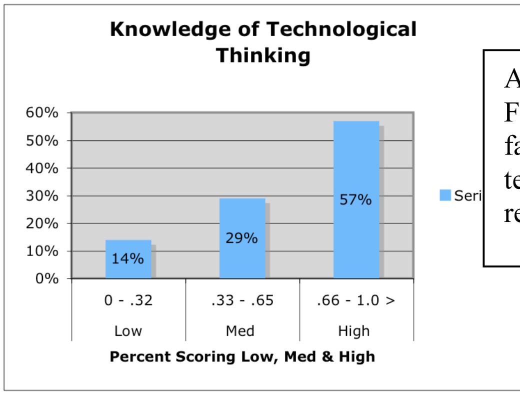
Results are reported for three groups: clinical faculty (14); students in the course Integrating Technology into the Curriculum to Support Student Learning and Inquiry 525 (26 students); and students in ConTEXT field placements (18 students).

Understanding the scores. A score of 0 to.32 on a dimension means that for every technology use a student recommended, less than a third of the time he or she indicated a) familiarity with the specific technology application, b) an adequate pedagogical rationale, or c) a student need that the technology might plausibly address. A score of .33 to .65 means that the student indicated these things roughly half of the time. A score of .66 to 1 or greater, means that they consistently included these elements in their recommendations, in ways that reflected understanding.

Clinical Faculty TLI Performance

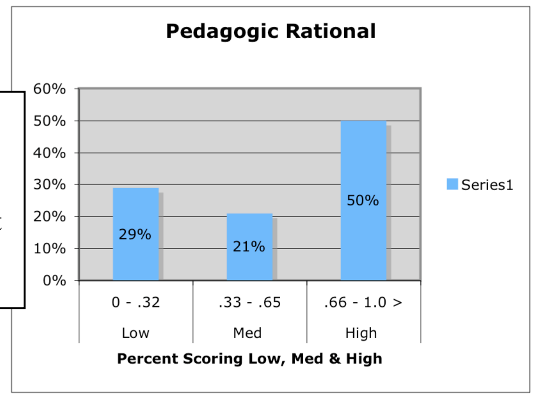
Figure 4 presents the TLI performance of 14 clinical faculty who received ConTEXT training – that is, a relatively intensive series of hands-on workshops run by Bank Street College technologists, followed by a semester doing their own 'action research project' around a technology activity of their choosing, guided by Bank Street faculty. The scores presented were gathered at the conclusion of this yearlong process. They thus reflect the performance of a handful of relatively experienced classroom teachers (chosen for their adeptness with 'progressive' teaching methods) after significant training and some classroom experimentation. .

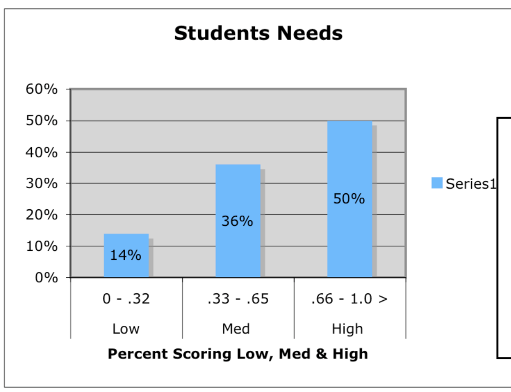
Figure 4: TLI Results for the Project ConTEXT Clinical Faculty (N=14)



About half of the trained Clinical Faculty consistently demonstrated familiarity with the specific technology applications they recommended.

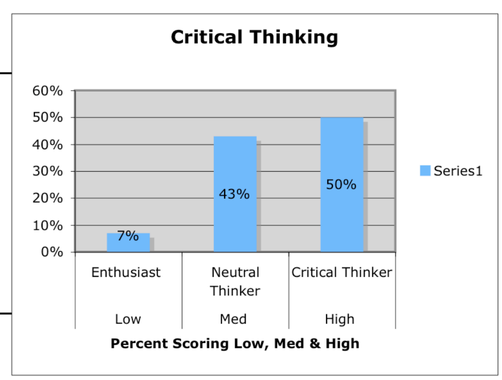
Half of the Clinical Faculty cohort consistently offered a pedagogical rationale for their technology recommendations. A third tended not to cite any rationale.





Half of the Clinical Faculty consistently connected technologies they recommended to specific students and their needs. Over a third did so for half of their recommendations.

Few of the Clinical Faculty were uncritical 'technology enthusiasts'; most offered at least some level of critical thinking about technology choices.



Student TLI Performance

Figure 5 shows TLI results for two student cohorts. The left column shows scores for students enrolled in the 1-credit graduate course TE 525, Integrating Technology into the Curriculum to Support Student Learning and Inquiry. The right column shows scores for a group of students who had field placements in ConTEXT classrooms. TE 525 students completed the Inventory during the last week of their 6-week course, or in the week following; ConTEXT students completed the Inventory during the semester immediately following their placement.

For both groups, the charts show the percentage of students scoring low, medium and high on the four key dimensions – 1) familiarity with technology applications, 2) citing a pedagogic rationale for technology use, 3) citing student needs addressed by technology, and 4) thinking critically about technology.

These results are descriptive of current skills for these cohorts only. We cannot infer from differences in performance that these differences were caused by TE 525 or ConTEXT experiences. However, several observations can be made about the scores on the different dimensions.

Figure 5: TLI Results for Two Student Cohorts
Percentage Scoring Low, Medium and High on Key Dimensions

Students in TE 525 (N=26) | **Field Placement Student Group (N=18)**

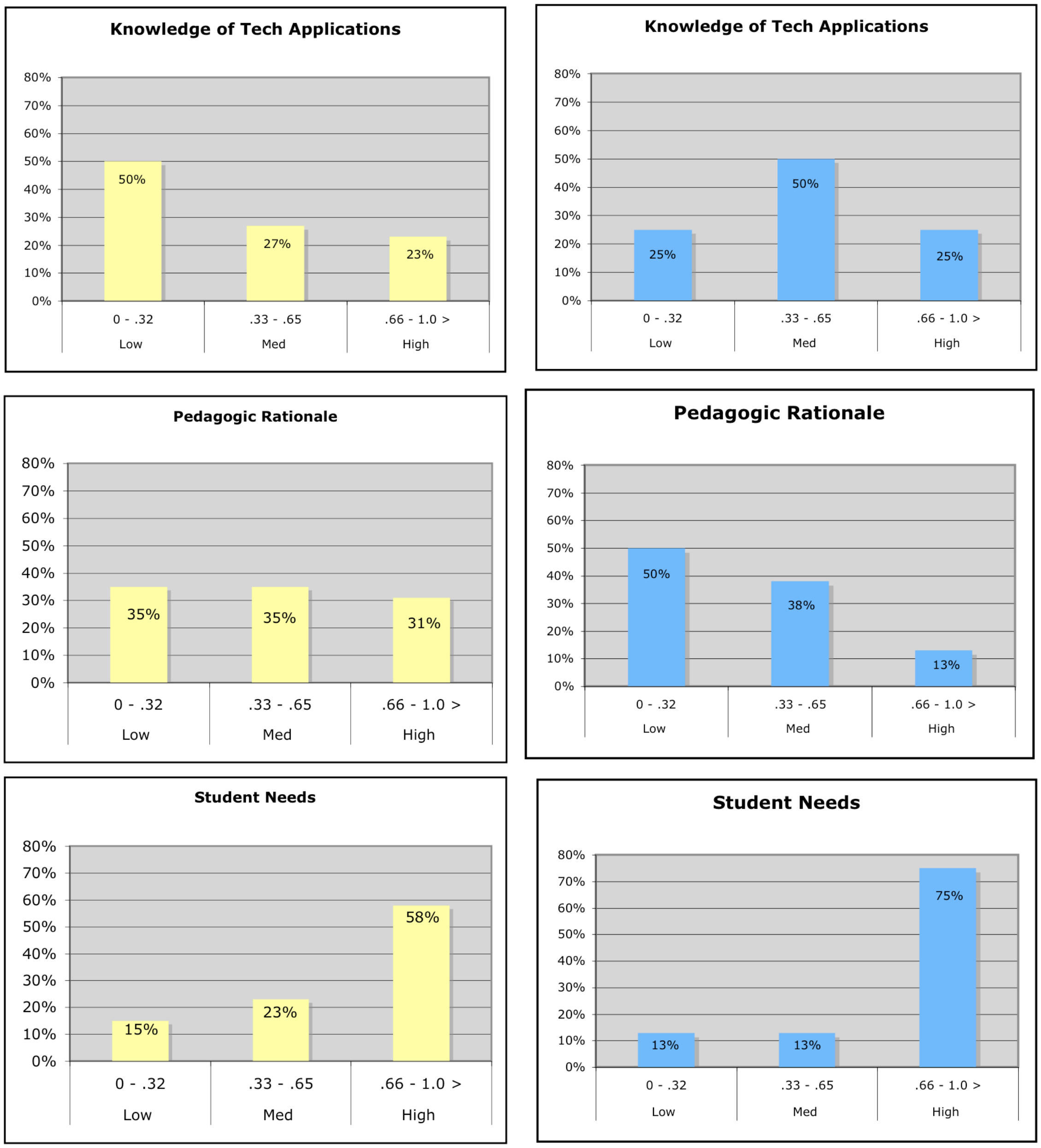


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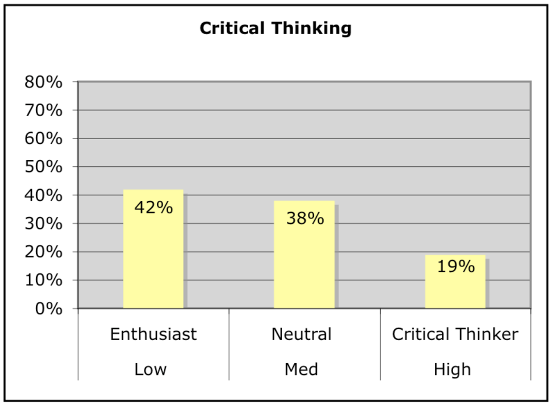
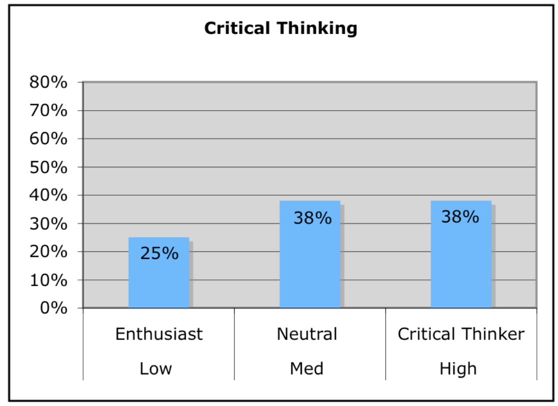
Figure 5 (continued)





Familiarity with Technology Applications. Fewer than a quarter of students in either cohort consistently demonstrated real familiarity with the technology applications they recommended. Based on their TLI responses, the majority demonstrated low or medium familiarity with tools ranging from the Internet to mapping software, online conferencing, and presentation software. Two exceptions, however, were clear: Students in both cohorts showed the strongest knowledge of digital cameras and concept-mapping software, such as Inspiration and Kidspiration. Many described the features and uses of these tools in ways that reflected concrete experiences with them, not just general familiarity as illustrated by the following quotes:

> *Concept mapping software also allows you to have a permanent record of the students' thinking that will let you come back to it later, add, modify, etc. and/or print it out for students to refer to later.*
>
> -- Jessica, field placement student

> *Individual stories can be parsed with the mapping software to help show relationships, story details, and plot elements.*
>
> -- Troy, TE 525 student

Student performance likely reflects the prominence of digital cameras, and concept mapping software in both TE 525 and in many of the ConTEXT classrooms, where teachers saw them as adaptable to many curricular uses, and appropriate for younger children, the main target of teaching. The fact that these were areas where instruction concentrated, and also areas where students performed strongly, suggests that students' experiences in TE 525 and ConTEXT classrooms are indeed having a measurable impact.

Providing a Pedagogic Rationale. Roughly a third of students in TE 525 consistently provided pedagogic rationales for the technology uses they recommend, while a somewhat smaller percentage of ConTEXT students did so. In providing pedagogic rationales, students mentioned the appropriateness or inappropriateness of technology to the curriculum, to students' general developmental level, or to factors such as the need for hands-on experience or more diverse kinds of materials.

Kids can focus on the concepts without being frustrated by their skills with pencils and crayons. The zoom in and out feature allows them to go beyond the limits of a sheet of paper.

-- Paul, TE 525 student

Students can use digital pictures of landmarks so the students can refer back to the photos to jog their memories.

-- Beth, TE 525 student

For K-2 children, I think the introduction to a unit is not the time to bring in technology. Read alouds, book browsing, and class discussions can meet the introductory needs of the unit.

-- Troy, TE 525 student

Citing Student Needs. A majority of both cohorts consistently cited student needs in their technology recommendations (58% for TE 525 cohort, and 75% for the ConTEXT cohort). Roughly half of these described technology helping general categories of students -- 'visual learners' or 'auditory learners', or those who get bored or 'antsy' and 'need motivation.' The other half were more concrete in their descriptions. They suggested, for example, that English Language Learners could benefit from the scaffolding provided by concept-mapping software; that map-making software could help those with grapho-motor challenges; and that creating a video story might help a child with language processing difficulties to communicate effectively without having to worry about grammar, accents, etc.

This will help students to understand and differentiate between story elements. Pictures will help students who have text processing difficulties and English language learners.

-- Jennifer, TE 525 student

Second language learners and your child with motor difficulties will enjoy the visual effects of this project. It may also keep your disruptive child more engaged. Your faster moving students can be challenged to compare their maps, look at distances, add in other features, try different kinds of maps etc.

-- Jessica, field placement student

Students' relatively strong performance in this area may reflect several things. First, it may reflect the general commitment of student-centeredness and student diversity at Bank Street College. However, an ability to connect *technology* to students and their needs does not necessarily arise from a general commitment to student-centeredness. Therefore, it may more likely reflect students' experiences in TE 525 and in ConTEXT classrooms, both of which emphasized the value of technology for particular kinds of students.

Critical Thinking. ConTEXT students demonstrated a relatively high level of critical thinking in their discussion of technology options; only a quarter were technology enthusiasts. In comparison, almost half of TE 525 students were enthusiasts, and half showed some level of critical thinking. Enthusiasts were people who tended to see mostly the *possibilities* of technologies, who recommended technology more frequently, and whose recommendations were not tempered by factors such as technology access, student ability level, classroom management realities, or compatibility with pedagogical style. Critical thinkers were people who frequently said technologies were *not* appropriate in a given instance, and whose recommendations *for* technologies were often tempered by consideration of students, teaching needs and management realities.

> *At the brainstorming step, it may be more effective to keep all students together, discussing the topic, rather than breaking them off into the small groups needed for most technology activities. Different entry points can still be provided by not only discussing orally but also recording students' responses, having handouts and resource books available, etc.*
> -- Courtney, field placement student

> *Well, you could shoot the video at this point, but I think since you are asking kids to do this from their heads, you could model this for the kids by jointly writing directions including landmarks for the walk that you did the day before.*
> -- Katherine, TE 525 student

The greater proportion of 'technology enthusiasts' among TE 525 students makes sense, since these are students who had just finished a 6-week course in which they were exposed to a range of technology tools, had hands-on experience with them, and discussed many of their possibilities for students. We would expect that, as students have more time to assimilate what they have learned, and use technologies with children in the classroom (such as the ConTEXT students may have done) their enthusiasm would be tempered by more critical thinking.

Discussion

Based on our diagnostic uses of the TLI and the data it generates, it appears that the field experiences that are part of Project ConTEXT have at most a modest impact on candidate's capacity to formulate technology-enhanced lessons that address student needs. This appears to be due to a variety of project-level factors, including: the part of the school-year in which the field placement occurred (which dictated whether candidates experienced a robust technology intervention or not); the prior technology experience of the cooperating teacher; and the circumstances of the specific school-university collaboration.

However, our analysis of TLI data does indicate where teacher candidates are relatively strong and weak in their thinking about technology integration. As such, it holds promise for wider application in assessing teacher's preparation for technology use. The Inventory helped distinguish among candidates' technology literacy along a range of dimensions outlined in the ISTE's (2002) standards for teachers, including such things as whether teachers' technology enhancements a) show adequate attention to developmental needs and student diversity; b) show some critical thinking in selecting software; c) anticipate technology-related classroom management issues and plan a course of action; and d) include strategies to facilitate students' higher-order thinking, critical thinking about electronic information, or technical skills. A critical area that the TLI did *not* function well in was gauging candidates' capacity to consider current research and theory when planning technology-rich learning activities. This is a dimension of candidate proficiency that should be addressed in future iterations of the assessment tool.

Using the TLI diagnostically, it appears that ConTEXT training for clinical faculty is having intended benefits: clinical faculty consistently exhibit specific knowledge of technology applications in their discussion of technology uses. More specifically, their literacy appears highest around uses of generic tools such as digital cameras, concept-mapping software and presentation software. Coupled with interview data this suggests that clinical faculty now view digital technology less as separate stand-alone computer applications and more as a range of options for helping children gather information and make meaning, as part of the continuum of classroom materials.

Attuneness to differing student needs
Two further finding bears mention. First, based on their TLI responses, teacher candidates in both TE 525 and ConTEXT field placements were remarkably attune to differences among students and their needs. Most candidates consistently mentioned students and student needs in explaining their technology recommendations. We can only speculate about where they developed this habit of thought – it may be that it is such a prominent and shared feature of the 'Bank Street approach' to teacher education that they bring it to technology work, willy-nilly; or it may be that their specific experiences in TE 525 or their field placements help reinforce this. Comparative work with the TLI across institutions with markedly different philosophies and approaches will help clarify this.

From 'Enthusiasts' to 'Critical thinkers'
Finally, teacher candidates taking the TLI could be grouped along a continuum from 'Enthusiast' to 'Critical Thinker' about technology and teaching/learning. Enthusiasts saw many potential uses and benefits of technology in all areas of a lesson, and provided some sound pedagogical rationales for them. Critical thinkers were more discerning, balancing their belief in technology's potential with a host of considerations including the cognitive load of new tools and materials, classroom management issues, and children's need for less mediated, non-technological experiences. (ISTE standards represent the Critical Thinking end of the continuum in their explicit emphasis on these multiple frames of reference in decision-making about technology.) TLI data suggest that some teacher candidates became Enthusiasts through project activities, while others moved more toward Critical Thinkers. We speculate that this may be a function of the developmental stage of the technology learner, as much as project activities. Further work on mapping the transition from 'enthusiast' to 'critical thinker' seems warranted.

Issues in Assessing Candidates' Technology Literacy Using Online Scenarios
As an approach to assessing teacher candidates' readiness to teach with technology, the TLI has several clear biases – belief in the value of hypotheticals to elicit more 'real-world' and 'applied' thinking, reliance on written language, a commitment to open-endedness. These may be a source of its strength, but they are also (as is often the case

with assessment approaches) a source of many challenges and limitations. We will briefly discuss several of these.

a) Hypothetical scenarios. We interviewed teacher candidates after they took the TLI and found that they mostly enjoyed the mix of imagination and concrete analysis involved in helping to enhance a fictional colleague's lesson. It was a compelling task that they said helped them focus and develop their thinking in useful ways. But developing and calibrating the lesson scenarios was difficult and time-consuming; they had to be specific enough to be realistic, and at the same time they had to be general enough so that users could plausibly connect a variety of technology tools to them.

b) Reliance on written language. Both the prompts and the user responses in the TLI are largely in written language. Beyond the fact of users' different facility with written language, writing in the *online* medium adds an additional wrinkle: People who are equally fluent writers may write a little or a lot, depending on whether they are accustomed to the highly abbreviated style of communication made prevalent by email, Instant Messaging, and wireless communication devices, or whether they enjoy the more traditional, elaborated form of written discourse.

c) The open-endedness of the task. To enhance the comparability of responses we have sought various ways of establishing a time limit for users in filling out the TLI. We have tried to advertise is as no more than a 20-minute exercise, and to use web-tracking data to see how long people have taken to complete it from beginning and end. But these are imperfect. We know in fact that the circumstances in which people fill out the TLI matter greatly -- we have seen people filling it out in 5-7 minutes in the college lobby before class, and we have seen them take more than 30 minutes on it in library.

d) Recruitment and incentives
Despite how engaging it is, the TLI is still, of course, a test, and people know it. Getting students and others to take it, in those instances where it is *not* a course requirement, has been challenging, and has required that we offer small incentives (coffee vouchers, cheap flash drives, etc.), and sometimes, that we set up dragnets in the college lobby to 'grab' students on their way to and from classes. Email solicitation of busy NYC teachers has proved to be an especially difficult sell, even with incentives. Our current approach is to 'lean on' existing college meetings in which we can colonize 20 minutes while people are together. But we have only begun to account for the differences among people who have filled out the TLI in quite different circumstances – at home via email, with a small technology incentive; on campus, as a course requirement; in the college lobby, in order to get a cup of coffee.

The challenge of scoring and reliability
All of the above issues bear greatly on the challenges of scoring user responses and establishing the validity and reliability of the responses. As with all constructed measures, attaining clarity about the dimensions and criteria on which responses will be scored, and then establishing that the tool yields sufficiently valid and reliable scores for early groups of test-takers, has taken a lot of time and energy, and ambiguities have

abounded. As in so many domains, the hoped-for efficiencies of using technology for data collection do not appear immediately – indeed, as the issues above suggest, the online medium makes things more challenging in the short run. It may be that efficiencies in using open-ended, real-world and case-based scenarios to assess teachers' technology learning will be reached only when the process of assessment becomes both more *participatory* and *pedagogical* at the same time – when the 'scorers' of these authentic performances are not just researchers, but the wider cadre of teacher educators who are themselves learners of varying levels of technology sophistication.

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Appendix A

TLI Scoring Criteria

The TLI scoring scheme assigns a score to subjects' writing about suggested technology activities in each of the following areas: familiarity with specific features of the medium; rationales provided for technology activities; the citing of students and different student needs; classroom management realities; and critical thinking about technology.

Here are the criteria used under each area:

<u>A. Familiarity with the technology application</u>

Here were looking for evidence of awareness and familiarity w/ digital tools and applications

- 0 = only mention the medium by given name (e.g., 'the web')
  no mention made of specific features
- 1 = mention features of media in a general way (e.g. 'the web is visual')
- 2 = mention specific features of the web that might have relevance for teaching / learning (eg, 'online maps can be revised to get views of students' own neighborhoods')

<u>B. Pedagogical Rationale -- 'fit' with teaching goals</u>

- 0 = no mention made of pedagogic purposes, and their fit with recommended technology tools
- 1 = general mention of pedagogical 'fit'
- 2 = user cites specific ways that technologies will serve the teaching goal

<u>C. Students and student needs</u>

- 0 = no mention made of student needs
- 1 = general mention of student needs (eg, 'all students will benefit', or 'visual learners will benefit'
- 2 = mention of one or more specific types of learners and their needs, and how technologies might address them

<u>D. Classroom management realities</u>

- 0 = no reference to classroom mgmt realities and challenges
- 1 = general reference to classroom mgmt realities
- 2 = discussion of specific classroom mgmt realities and how their bear on tech decisions

<u>E. Critical thinking about technology</u>

- 0 = Technologies' benefits are said to be inherent and universal (e.g. "Inspriation is the perfect pre-writing tool"; "Students find computers so motivating."
- 1 = Technology benefits are said to depend on additional factors – e.g., student skills, classroom environment, teacher support.
- 2 = Talk about technology is explicitly critical, i.e. specific disadvantages as well as advantages are discussed, in relation to teaching goals, students and their needs, and/or the quality of the learning experience.

[i] Interviews with clinical faculty clarified some of the reasons why student teachers did not always experience technology-related activities during a placement. First, simple timing was often a factor. The clinical faculty's technology work with children might happen outside the six or eight weeks of a given students' placement. Second, student teachers differed in their interests, readiness and the emphases of their programs, so that they sometimes focused on teaching challenges unrelated to technology. Third, differences in school cultures and the technology supports available in different schools led to barriers in implementation of technology projects that students could observe and learn from. At Bank Street School for Children, for example, teachers' work lives were quite stable and they enjoyed steady technology access; these factors led to higher follow-through. In several of the NYC public schools, however, teachers changed positions frequently and had more difficulty implementing their projects as planned.