The Influence of Teachers' Perceptions on Usage of an Educational Technology: A Study of Project LISTEN's Reading Tutor

by

Peter M. Kant

B.A Vassar College, Asian Studies

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COMMITTEE SIGNATURE PAGE

Committee Member	**Affiliation**
	University of Pittsburgh School of Education Administrative & Policy Studies
Dr. Maureen Porter (Advisor)	
	Carnegie Mellon University Robotics Institute, Language Technologies Institute, Human-Computer Interaction Institute, and Center for Automated Learning and Discovery
Dr. Jack Mostow	
	University of Pittsburgh Department of Psychology, Learning Research & Development Center
Dr. Janet Schofield	

The Influence of Teachers' Perceptions on Usage of an Educational Technology: A Study of Project LISTEN's Reading Tutor

Peter M. Kant, M.A.

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Abstract: This study looked at factors influencing teachers' perception and usage of Project LISTEN's Reading Tutor, a computerized tutor used with elementary students in 9 classroom-based, 10 computer lab-based, and 3 specialist-room school settings. Thirteen interviews and 22 survey responses (of a possible 28 teachers) examined teachers' perception of the Reading Tutor and suggested that teachers' belief in the Tutor influenced their usage of it ($r = .46$, $p < .03$). Three factors seemed to influence teacher belief: 1) perceived ease of use ($r = .52$, $p < .01$), 2) teachers' reported experience with computers ($r = .41$, $p < .04$) and instructional technology ($r = .48$, $p < .03$), and 3) perceived technical problems such as frequency of technical problems ($r = -.44$, $p < .04$) and speed with which problems were fixed ($r = .49$, $p < .02$). Analysis of these factors suggested four themes that cut-across factors and seem to influence the way teachers evaluate and use the Reading Tutor – the technology's degree of convenience, competition from other educational priorities and practices, teacher experience and/or interest with technology, and data available to teachers and the way teachers prioritize that data. These results suggest that improving convenience of the Reading Tutor, instituting specialized training programs, and improving feedback mechanisms for teachers by providing relevant, situated data may influence teacher belief in the Reading Tutor and thereby increase teacher usage. This study contributes to current literature on educational technology usage by supporting previous literature suggesting that teacher belief in the importance of a technology influences their use of it. One unique feature of this study is that is uses both quantitative and qualitative methods to look at the research questions from two different research perspectives.

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This study's aim was to assess teacher perception of the Reading Tutor independent of Project LISTEN in order to bring an external perspective to the issues facing the organization and increasing teacher usage of the Reading Tutor. The views expressed in this study reflect those of the author and do not necessarily reflect the views of Project LISTEN

Dedication

To Laura,
with love and gratitude.

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Introduction & Literature Review

In this thesis, I look at factors influencing teachers' perception and use of Project LISTEN's Reading Tutor (RT) – a computerized tutor used by elementary school students to help teach them how to read. I focus on teachers because they are key decision makers who decide which educational practices their students engage in on a daily basis. I examine how teacher beliefs influence their usage of the RT, what factors influence those beliefs, and suggest ways to influence their beliefs and improve their usage of the RT in school. In this way, the RT can serve as a case from which to better understand teacher perception of educational technology and generate suggestions for improving the use of other effective educational technologies.

Over the past twenty-five years, scholars, policy-makers, technologists, and politicians have looked to computers as a technology capable of improving – even revolutionizing – the U.S. educational system. They have backed this belief with a strong commitment of monetary resources and policy initiatives. Cuban (2001) cites McKinsey and Company estimates of technology expenditure for schools increasing from $3.3 billion, or $75 per student in 1995 to $5.5 billion, or $119 per child in 1998-1999. President Clinton's 1996 $2 billion Technology Literacy Challenge Fund and accompanying four-goal policy initiative illustrate the political and financial importance placed on technology in the schools (Cuban, 2001).

In spite of significant technology investment in computers and networks for schools, some decision-makers, technologists, and educators are concerned that many of these new technologies are not being used to a degree commensurate with the investment. In *Oversold and Underused: Computers in the Classroom*, Cuban states that even with increasing usage since the early 1990's, teachers continue to use computers infrequently:

for elementary and middle schools, “about 1 in 3 [teachers] are occasional users, and about 1 in 10 uses the technologies daily.” Student reports of computer usage in school put 5th graders at 24 minutes a week and 8th graders at 38 minutes a week. Cuban also considers the way in which computers are used: “In the end, both supporters and critics of school technology (including researchers) have claimed that powerful software and hardware often get used in limited ways to simply maintain rather than transform prevailing instructional practices.” (Cuban, 2001) If correct, this casts in a poor light the large expenditures on technology such as computers that rapidly depreciate and become obsolete. Technology use in education (and ways to increase technology use) has thus become an increasing concern for decision-makers and scholars.

Scholars have taken up the challenge. Schofield (1994, 1995) and Zhao et al. (2002) conducted studies examining factors that influence the use and integration of technology into the classroom. Schofield focused on "how computer usage changes classroom social processes and on how the social context shapes computer usage" during a two-year study in a Pittsburgh-area school. Her study found that the general introduction of computers into the classroom enhanced student motivation, changed peer-interaction patterns, and altered the teacher's role. She also examined social, organizational, affective, and cultural barriers to computer usage.

Zhao et al. (2002) evaluated the success of integrating various technologies into classrooms and identified “factors that facilitate or hinder teachers' use of technology in their classrooms.” They organized their findings into three conceptual categories: teachers, technology, and context. They suggest greater attention to professional development, ease-of-access to technology combined with incentives to use it, and conceptualizing

classroom technology adoption and usage as evolutionary rather than revolutionary. (Please see Table 7 in the appendix for a chart of factors identified in three studies that I primarily drew upon for this thesis' analysis.)

Contextual factors such as workplace environment, support structures, and teacher community also influence the degree of technology usage and innovation in the classroom. McLaughlin (1993) looked at workplace factors that influence a teacher's thinking about and exercise of classroom practice. In looking at the way workplace factors shape teacher responses to student needs, McLaughlin focused on the interaction between school-level, departmental-level, and teacher-level goals for students. McLaughlin's work stresses the central role teachers play in schools for determining which student needs are met and in what manner. Because teachers control the way classroom time is spent, they are influential stakeholders in determining the student use of education technology. I posit that teachers are the determining agents for whether or not the Reading Tutor is used, to what degree, and in what manner – thus I focus the study on teachers.

The next two studies looked at teacher perception of technology's capacity for changing their practice. Granger et al (2002) asked "What factors do teachers perceive as contributing to successful classroom implementation of ICT [Information and Communication Technology]? How do these factors act, and interact, to make their contributions?" From interviews conducted in 12 schools across Canada, they found that successful classroom implementations of IT involved 'just-in-time' learning (getting informal training at needed moments), collaborative relationships among teachers, and a commitment to and belief in using technology to help their students. Dexter, Anderson, and Becker (1999) looked at teachers' views of computers as a catalyst for changing their

teaching practice. They found that teachers thought computers helped them change their teaching practices, but that teachers felt that "reflection upon experience, classes taken, and the context or culture of [their] school" were more important catalysts behind the change.

Zhao & Frank (2003) tested an ecological metaphor – likening technology change to the introduction of new species to an ecosystem – to describe technology adoption and usage in schools by conducting surveys and interviews in a variety of Great-Lakes region school districts. They found that the metaphor was useful in examining technology use in schools and that teacher predisposition toward technology was an influential factor to their use, though perceived benefits to students from technology could make teachers more responsive to technology. Teachers "calculate the costs and benefits of adopting technology" and base their decisions upon "perception rather than 'reality,'" a position that agrees with the previous two studies. They conclude by calling for more research into influences on teacher perceptions of technology.

Teacher perceptions influence teacher pedagogical belief and practice, and studies suggest that technologies designed to be self-contained and requiring little teacher oversight or input, while potentially effective, risk relegation to minor roles in the classroom if teachers believe they are not useful or do not meet the demands of their practice. Schofield (1995) explicitly addresses this issue, stressing that in order for an educational technology to be used effectively, it must be in-sync with teacher belief and practice. Zhao et al. (2002) supports this point as well, citing distance from existing practice and pedagogical belief as factors influencing successful technology implementation in the classroom. These findings suggest that it is important to look at the way the Reading Tutor fits into teacher practice *and* the beliefs supporting that practice

when we consider usage. Thus, qualitative research that can address the complexities of teachers' daily practice and their underlying beliefs regarding technology can help us to better understand ways in which they might influence usage.

These studies also deal with a belief implicit in debates over technology use in education: that technology can and will change education practice in positive ways. Cuban (1986) addresses this belief from a historical perspective, tracing classroom use of technologies such as radio, film, and television since 1920. He describes a cycle of "exhilaration / scientific-credibility / disappointment / teacher-bashing" that moves from high expectations for a new technology's impact on education, research confirming the technology's status as equal-to or better-than-standard practice, slow adoption and limited usage, to blaming teachers and an intransigent educational system for poor use.

This cycle described by Cuban resembles a technology hype curve identified by the Gartner Group, a research and advisory firm for technology and business industries (Gartner Inc., 2002). **Figure 1** provides an illustration of the cycle, tracing the course of rapidly growing expectations followed by disillusionment and eventual understanding of a technology's relevant application(s). This model may explain the slow adoption of technology in schools and Cuban's teacher-bashing cycle. Hype outpaces the realistic adoption of technology by a large, socially- and organizationally-complex institution: the public school. Furthermore, if we accept Schofield's likely proposition that technology influences school culture and school culture influences technology, it seems reasonable that it takes a while for schools, teachers, and new technology to adapt to one another.

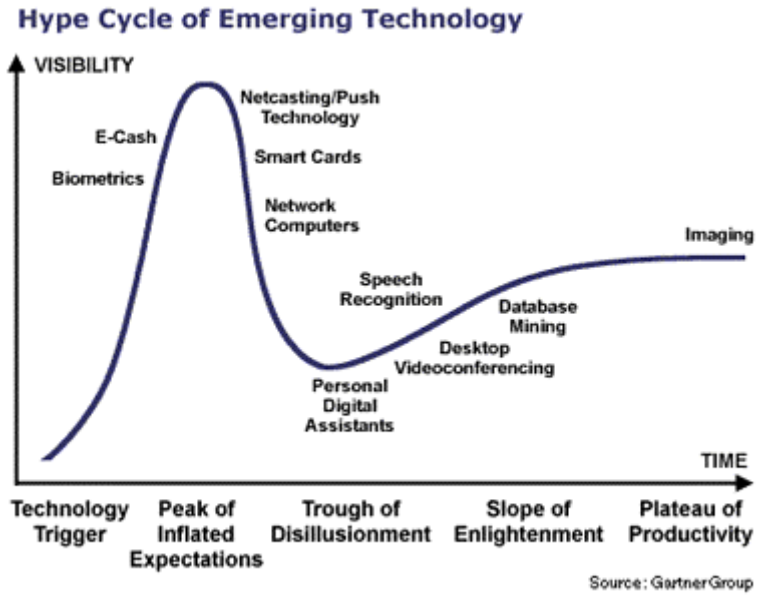

Figure 1: Example of hype cycle of emerging technology (Gartner Inc., 2002)

Another way of looking at the slow adoption and low usage of technology in the classroom is to consider technology as auxiliary to the central role the teacher plays in schools. From this perspective, technology is useful insofar as it is accepted and incorporated into current teaching practices and beliefs – one reason older technologies such as the blackboard and textbook are used consistently more often than newer technologies such as videos, computers, and the internet. In order for a technology to be accepted, it must 'fit' within the existing structure of classroom practices, otherwise it creates a failure of fit in which the technology is rejected. If we consider Schofield's conception of bi-directional context-technology interaction and Cuban's historical critique of classroom technology use from this perspective, it suggests that new technology should either meet needs that exist within current practice *and/or* improve practice through the

timely implementation of new technology combined with sufficient training and support. This perspective also helps us consider issues of "scaling-up" or spreading educational technology use at state or national levels, an issue Zhao et al. touch upon. It is also one that is relevant to future use of Project LISTEN's Reading Tutor – a computerized reading tutor designed to help elementary school students learn to read.

Both perspectives – over-hyped expectations and a failure of fit – support Cuban's critique of the underlying belief behind this teacher-bashing cycle that technology alone will change learning for the better. Research or policy that blindly adheres to this belief risks inappropriately blaming teachers and the schooling system for failure to incorporate technology and/or inadequately addressing the underlying problem of usage. We need rigorous research that considers the way technology, actors, and contexts interact. Furthermore, we also need research to ensure that technologies deployed in educational environments effectively improve student learning.

This study seeks to understand factors relating to teacher perception and use of educational technology by addressing the following questions relating to Project LISTEN's Reading Tutor:

1. **What factors influence teachers' perceptions of the Reading Tutor?**
2. **How do these factors influence teachers' perceptions of the Reading Tutor?**

This study provides decision-making information to the director and staff of Project LISTEN to help them better understand teacher perception and in order to develop ways to increase usage of the Reading Tutor. This study contributes to scholarship by examining

issues about teacher perception of educational technology raised by the scholars cited above. It draws upon factors identified in previous research, particularly by Schofield (1995) and Zhao et al. (2002), and incorporates new factors identified using a Grounded Theory, or inductive reasoning, approach (Strauss, 1987; Strauss & Corbin, 1990). These factors are used to analyze the case of the Reading Tutor in order to address this study's questions about the influence teacher perception has on usage of an educational technology.

Project LISTEN

This section describes Project LISTEN, the Reading Tutor, the settings in which the Tutor is used, the broader context of Project LISTEN and participating schools, and my relationship to Project LISTEN.

Description of Project LISTEN from the project website (Project LISTEN, 2004)

Project LISTEN (**L**iteracy **I**nnovation that **S**peech **T**echnology **EN**ables) is an inter-disciplinary research project at Carnegie Mellon University to develop a novel tool to improve literacy, an automated Reading Tutor that displays stories on a computer screen, and listens to children read aloud. To provide a pleasant, authentic experience in assisted reading, the Reading Tutor lets the child choose from a menu of high-interest stories from *Weekly Reader* and other sources – including user-authored stories. The Reading Tutor adapts Carnegie Mellon's Sphinx-II speech recognizer to analyze the student's oral reading. The Reading Tutor intervenes when the reader makes mistakes, gets stuck, clicks for help, or is likely to encounter difficulty. The Reading Tutor responds with assistance modeled in

part after expert reading teachers, but adapted to the capabilities and limitations of the technology. The current version runs under Windows(TM) 2000 on an ordinary Pentium(TM) with at least 128MB of memory. Though not (yet) a commercial product, the Reading Tutor is used daily by hundreds of children, as part of studies to test its effectiveness. Project LISTEN is supported by NSF under ITR/IERI Grant REC-0326153, and by the Heinz Endowments.

Who uses the tutor, where, and in what manner?

Project LISTEN's Reading Tutor (RT) is used in three settings: classrooms, computer labs, and reading support rooms. Classroom settings typically have two to four computers per classroom. The teacher sends students to work with the RT individually or in small groups arranged in "centers" where students rotate from activity to activity. Lab settings involve a teacher signing up for or regularly scheduling time in the computer lab to bring their entire class to use the RT. Finally, the RT is used in reading support and learning support areas in an individualized manner determined by the specialist.

Within the schools, there are three types of teachers who use the RT: classroom, reading support, and learning support. Classroom teachers teach a single class and use the RT in either classroom or lab settings. Reading specialists meet with small groups of students who have been pulled from other classes for special instruction. They use the RT with their students typically in their specialist's office or, occasionally, in the computer lab. Learning specialists teach children with learning, emotional, or social difficulties. They are assisted by aides who may or may not accompany individual students to other classes. Learning specialists typically teach special needs children in their own classrooms. This

study had nine classroom-based teachers, ten computer lab-based teachers, and three specialists.

Project LISTEN and the participating schools

Project LISTEN's Reading Tutor was typically introduced into schools through key persons such as interested administrators or reading specialists who were exposed to the program, and through recruiting events aimed at school board members and school administrators. School administrators made the decision to adopt the RT with varying degrees of teacher input ranging from little to significant consultation.

The RT was assigned to different teachers through processes ranging from teachers' volunteer participation to assignment by school administrators. The RT was installed in schools typically within the first month or two of school. Most teachers knew about its installation before hand, though some did not find out until the arrival of the RT in their classroom.

Teachers typically were introduced to the RT far in advance of adoption with Project LISTEN staff doing a short presentation followed by time for teachers to work with the Tutor. Subsequent training typically occurred at the beginning of the school year with Project LISTEN staff showing teachers how to operate the program, giving troubleshooting suggestions, and providing contact information for technical support. For teachers starting RT use later in the school year or for those who missed the initial training sessions, Project LISTEN field staff instructed those teachers one-on-one in their classrooms or computer lab.

In the negotiations with school administration during the adoption period, Project LISTEN typically prescribed that teachers used the RT at least 20-30 minutes per day, every day, in order to improve student learning and maintain the integrity of the controlled studies being conducted using the RT. Though usage levels were prescribed, teachers had a great deal of control over how frequently their students would use the RT – the likely reason behind the great variation in levels of usage by teacher.

The RT needed to be installed upon a computer in order to be used. High- and medium-SES schools already possessing computers labs had the program installed onto existing computers. Low-SES schools, on the other hand, required the use of Project LISTEN's computers which were lent to them for the duration of the study.

Project LISTEN provided technical support for the RT in addition to the technical support already present at schools. Though low-SES schools had less school-based technical support than did high-SES schools, there appeared to be little difference in Project LISTEN field staff technical support between schools (based on my interpretation of teacher comments during interviews, informal conversations with teachers, and shadowing of Project LISTEN field staff). The field staff visited schools at least once every ten days to two weeks, typically more frequently. They also responded to new problems as the occurred.

The RT and Project LISTEN's Teacher Tool – a web-based application that showed student frequency, duration, and participation of using the RT – provided teachers with summaries of their students' usage and performance. A few lab-based teachers commented on attending to the information displayed by the RT during sessions and a few

teachers commented on using the Teacher Tool, though none seemed to use it in a systematic manner.

The retention of the RT from year to year in schools is a factor I will not cover in this study. However, I would like to provide some retention data to help clarify the context and influence retention can have on usage. The Assistant Director of Project LISTEN provided the following description regarding school retention of the RT:

> The total number of participating schools remained fairly constant from 01-02 through 03-04 (7, 8, 7). Between the first and second of those academic years, we gained two and lost one; between the second and third, we gained two and lost three. Since this spring, five schools have declined to continue, and we're now discussing new studies with four schools (possibly more), so it's still too early to say for sure (C.R. Taylor, personal communication, August 13, 2004).

If a school does not retain the RT from one year to the next, teachers are unable to continue using the program. One future research direction of value would be to explicitly study what factors influence retention of the RT from year to year. I describe in the conclusions section correlations from survey data collected in this study between teacher perception of administrative support, school SES, and RT setting which suggest that retention may be influenced by those factors. Furthermore, interview comments suggest that the administration at the school and district level influence the decision regarding retention of the RT. Also, the theme of competition between educational practices and teacher priorities (which appears later in this study) may provide a useful way for considering retention decisions. Future research examining the role school and district administration

play in retention of educational technologies like the RT would be helpful in understanding challenges to educational technology retention, adoption, and, indirectly, usage.

My relationship to Project LISTEN

This study arose out of my interest in issues influencing educational technology usage and the opportunity afforded by Project LISTEN's director's interest in better understanding and increasing usage of the RT. This study was conducted independently of Project LISTEN, though the program staff assisted this research by facilitating access to and providing initial contacts with the schools in which the RT was used. Project LISTEN staff also provided computed usage data to compare with measures of teacher perception. Finally, the program director provided financial support through the purchase the N6 software program to assist in the analysis of the interview data.

One potential conflict of interest arising out of this study is that the director of Project LISTEN, Dr. Jack Mostow, is on the committee for approval of this thesis. However, final approval for this thesis lies in the hands of my academic advisor, Dr. Maureen Porter, and all committee members developed a consensus during the thesis defense regarding which aspects of the thesis needed revision before final submission. In the next section, I discuss the two primary objects of this study: teacher usage and teacher perception.

Core concepts

This section defines the two core concepts I examine in this study – usage and teacher perception – and the way in which these concepts were operationalized and measured.

Usage

Project LISTEN staff define usage in terms of frequency, duration, and participation. Frequency is measured by the number of "user-days" or days on which a student uses the Reading Tutor. Duration is the number of minutes the student uses the Reading Tutor on a given day. Participation is the percentage of students using the Reading Tutor out of those enrolled in the program within a class (Mostow & Beck, 2003; Mostow et al, 2003; Mostow et al, 2002).

Using data computed by Project LISTEN from the Reading Tutors covering the 2003-2004 academic year, Project LISTEN staff took the average minutes per week per user as a metric by which to evaluate usage. "Minutes" is total minutes of usage from September 2003 through May 2004 by class. "Week" is the number of weeks where there was at least one session in the class, which excludes weeks before the Reading Tutor was installed, vacation weeks, and weeks after the class stopped using the Reading Tutor. "User" is the number of users (students) per class enrolled on the Reading Tutor, excluding teachers and test users used for troubleshooting.

The formula is as follows:

$$\text{Usage} = \frac{\text{(Total minutes)}}{\text{(\# Weeks) * (\# Users)}}$$

I chose to use this metric because it served as the best single measure of usage that could account for duration (average minutes), frequency (per week), and participation (users). The statistic accounts for different class sizes and different start and stop dates by class, two of its greatest strengths. However, the statistic excludes potential zero-usage weeks that were not vacation weeks or those used for standardized testing. The statistic also is unable to account for students who drop out of a class or move away from the school. This statistic is especially problematic when calculating the usage for specialists. For example, a specialist may work infrequently with a large number of students – they may use the RT a lot, but because there are a high number of users, it would lower their usage statistic. Alternatively, a specialist may intensively use the RT with only one student over a short period of time and thereby generate a high usage statistic which does not reflect the use of the RT with many students over a long period of time. While these weaknesses present some challenges, the benefits of accounting for variation in number of users and stop and start dates by class outweigh the smaller pitfalls of zero-usage weeks, student attrition, and specialist usage variability. The range of usage statistics and usage category by teacher are listed in table 5 of the appendix.

In order to compare usage to teacher interview comments I categorized teachers' actual RT usage into three categories – 'high usage,' 'medium usage,' and 'low usage' – by dividing teachers into three equal groups based on their usage statistic. There were seven 'high usage,' eight 'medium usage,' and seven 'low usage' teachers. I chose to use these categories because this provided numerically similar groups for ease of comparison. One weakness of this division is that very high and/or very low usage statistics may be grouped with others that tend toward the mean. This grouping could thereby increase the range of

usage statistics represented in the high and low categories. However, I used real usage numbers in calculating the correlations between survey items. By using the real numbers, the correlations accurately reflected the variation in usage statistics. I only used the usage categories to compare general trends in usage with comments made by the interviewed teachers.

Teacher perception

Teacher perception refers to the beliefs, thoughts, and feelings of elementary school teachers about the RT. Granger et al (2002) and Dexter, Anderson, and Becker (1999) both discuss the importance of considering teacher perceptions regarding technology and changing practice and justify studying teacher perceptions as related to educational technology usage. I focused on the importance teachers placed on using the RT in their practice. I measured teacher perception through qualitative interviews and quantitative surveys.

I coded transcripts of the semi-structured interviews conducted with teachers using the RT. The categories I used to code the transcripts were initially drawn from the research discussed in the literature review section and then modified based upon relevant categories that emerged from the interview process. The codes are discussed in the data analysis section and are listed in the appendix (see appendix, Tables 7 & 8).

I also distributed surveys to supplement the semi-structured interviews and quantify teacher perceptions of the RT and their use of it. The surveys focused on teacher experience with technology, attitudes toward technology, perceived support from others, and technical problems. I analyzed the survey responses using SPSS. A copy of the survey

is included in the appendix (see appendix, Table 10). Finally, I compared the results of the interview and survey data to look for similar patterns in teacher perception of the RT by using the N6 qualitative software program, software that helps a researcher organize and relate coded data. In the next section, I describe the methods used in this study.

Methods

In this section, I describe selection of participants, approach, and procedure used to gather the interview and survey data.

Selection of participants

I chose to focus on teachers rather than administrators or tech support personnel because much of the educational technology usage literature focuses on teacher influence over whether or not, or the manner in which, a new technology is used. While administrators likely influenced whether the RT was brought into the school at all, I chose to focus on teachers and their day-to-day decisions about whether they used the RT and, if so, in what manner they used it. I included all eligible users currently using the RT at the time of the study as potential participants due to the small sample size of the population (28 teachers) and difficulty gaining access to previous RT users.

As of the 2003-2004 school year, Project LISTEN had deployed the RT in seven schools in four districts within the Greater Pittsburgh area. Project LISTEN also had RTs in North Carolina, Chicago, and Vancouver, B.C. Due to limitations in time, funding, and the scope of this project, I considered only Pittsburgh-area schools. I selected four schools from this sample at which to interview teachers by looking at differences between schools

in teacher usage and school socioeconomic status (SES). In order to diversify the sample and collect more data, I expanded the scope during the interview process to include six schools. I did not include the seventh school because by that point I had sent surveys to all teachers using the RT and had a sufficient number of interviews from the other six considering the time constraints of this study.

Usage data by teacher and school came from Project LISTEN's password-protected report server which computes student number of sessions, session duration, and the percent of RT-enrolled students in each class using the RT. For my initial analysis, Project LISTEN staff generated a report showing December 2003 to February 2004 number of sessions and average session length which I used to initially categorize usage and select teachers. In my final analysis, I used a measure of usage generated from the entire 2003-2004 school year data in order to get a more comprehensive measure of usage. A table listing usage statistics and teacher usage category is included in the appendix (see Table 5).

I determined district SES characteristics by examining the school and district report cards on the PA Department of Education's website (PA Dept. of Education, 2004). I used the percentage of students enrolled in the school and district who classified as low income to determine SES. These statistics of the districts and schools are listed in the appendix (See Table 6) and can also be found on Pennsylvania Department of Education Website.

I analyzed Project LISTEN's usage data to identify different levels of usage between schools and between teachers within a given school. I selected schools based upon differences in usage between teachers within the school, differences in usage between schools themselves, and differences between schools in SES characteristics in order to

provide a diverse sample. The sample size was too small for random selection and an intra- and inter-school comparative approach offered a relevant perspective given the purposes of the study.

Access

I explained to teachers when I met them that I was conducting my Master's thesis on teachers' views of Project LISTEN's Reading Tutor. I told them that I was conducting this research independent of Project LISTEN and was not formally affiliated with the Project. I also explained to the teachers that I would protect the confidentiality of their remarks, that their comments would be identified by a code number only, and that their identity would not be revealed to Project LISTEN staff.

I initially contacted 18 RT-using teachers at the four schools I selected in order to get as comprehensive a picture as possible on teacher perceptions about the RT within each school. As I continued the interview process I expanded the sample to include two other schools in order to gather more data. I did not include the last possible school for potential interviewees because of the time constraints of this study and because I was seeing few new relevant patterns in the last few interviews of the 13 I had already collected. In the end, I interviewed thirteen teachers using semi-structured interviews and a survey to gather data on teacher perceptions. All teachers interviewed were still using or had just stopped using the RT at the time they were interviewed. I mailed the survey to the teachers in all seven schools using the RT in 2003-2004 and received an additional nine responses for a total of 22 (out of 28 total teacher) survey responses.

One weakness of this approach had to do with a representative sample and sample bias. I did not have 'importance of use' ratings from the last six non-respondents, but their average usage statistics (33.1, SD 22.6, n = 6) were similar to the survey-only responses (33.4, SD 15.3, n = 9) and significantly lower than the interviewees (40.2, SD 19.2, n = 13). The interviewed group had higher usage level, suggesting they may have been more interested in the RT and more likely to volunteer to participate in the study. ("SD" represents the 'standard deviation,' or measure of the variation in a distribution, and is equal to the square root of the arithmetic mean of the squares of the deviations from the mean).

Almost all of the interviewees rated 'importance of use' higher than did the teachers who only responded to the survey. For example, average 'importance of use' for interviewees was 4.08 (SD = 0.64) while the average score for survey-only participants was 2.33 (SD = 1.00). This fact indicates a likely bias for interviewees to be more positively inclined toward the RT than survey-only respondents. This makes sense given that the teachers who liked the RT would likely be more interested in participating in a study about it. Another possible explanation is that after speaking with me about the RT, the interviewed teachers felt more positively inclined towards the RT, and therefore gave higher ratings on the questionnaire. However, the interviewees also tended to have higher levels of usage than those who only responded to the survey. My interview would obviously not have affected teachers' actual usage levels. I also think the interview was unlikely to have affected their survey responses because teachers filled out the surveys privately, I made it clear that I was not part of Project LISTEN in my introduction, and I explained that the information they provided would be not be able to be linked to them by

Project LISTEN staff. While the sample was biased, it remained informative because teachers who rated using the RT as important used it more than those who did not. A useful follow-up to this study would be to interview low users who did not participate as they may provide a more candid account of negative aspects of the RT or why they used it less than other teachers.

The usage statistics provided a picture of how much teachers used the RT, but not what factors influenced their usage. I used interviews and surveys in order to provide both qualitative and quantitative sources of data from which to triangulate which factors seemed to be influencing teacher perception.

Procedure

I conducted site visits with Project LISTEN field staff and introduced myself to participating teachers as a researcher conducting an independent study of the RT. I then recruited teachers using a letter of introduction and additional site visits. I arranged interview times during or just after the school day in order to make the interview convenient for the teachers. Each interview lasted between 15-40 minutes.

I introduced each interview with an explanation of the study and the participant's rights as a research subject. This included an explanation of the potential risks and benefits of the study, that their participation was voluntary and they could choose to stop at any time, and that the information they provide would be used to better understand the way teachers think and feel about educational technology and the RT. The interviews were semi-structured, using pre-generated questions to guide the discussion and probes to clarify points of interest or confusion. I tape recorded the interviews for transcription and

took notes to help guide my thinking. At the end of the interview I asked participants to fill out a survey composed of Likert-scale and short-answer questions. I also transcribed and appended any comments that teachers wrote on their surveys. I recorded in my notes teacher comments before and after the tape-recoded interview in order to consider them during my later analysis of the data. Please refer to the appendix for a list of the interview questions (See Table 9) and a copy of the survey (See Table 10).

I sent surveys to teachers who did not participate in the interviews in order to receive their thoughts on the RT as well as to increase the sample size for the quantitative analysis of the surveys. Another reason I contacted additional teachers was to attempt to deal with the selection bias of the interview-only participants – participants who were more inclined to volunteer to interview were more likely to have favorable impressions of the RT (as the survey data later confirmed).

Data analysis

In this section, I describe the process by which I analyzed the interview and survey data. The analysis included both quantitative and qualitative techniques and associated software programs.

I identified relevant factors to technology usage from the literature, converted them into codes, and used those codes to look for themes in my interviews relating to RT usage. I synthesized a list of factors that influence technology use as identified in Schofield's (1995) and Zhao et al's (2002) studies. I used this list of factors as a foundation for developing my own concepts and codes to use with the interview transcripts. A list of

these synthesized factors identified from their relevant sources is in the appendix (see appendix, Table 7).

I transcribed the interviews into the N6 software package – a qualitative software package designed to help researchers organize, code, and retrieve qualitative data – reviewing my notes, and relating what I had heard and read to the list of synthesized factors. I then reconciled this list of factors I had drawn from the literature with new ones that emerged from my experience reflecting on the interviews. After briefly testing this new set of codes, I organized them to cover the major themes I saw emerging from the interviews. I then coded the interviews. The code structure is listed in the appendix (see appendix, Table 8). Next, I entered the survey data into a spreadsheet application and imported them into N6 as the base-data or demographic information. I used this base-data to compare remarks the teachers made in interviews with information supplied from their surveys.

Last, I used N6's "search and compare nodes" functions to look for patterns within the coded data. These searches included vector and matrix searches of base-data to coded interview data. These functions helped me relate the number of teachers making comments about a coded topic with base data describing their reported habits or objectively measured usage. In this way, I was able to link the qualitative interview data and the quantitative survey data and thereby look at the overall picture provided by those two methodological perspectives.

I used SPSS to look for statistically significant correlations in the survey data that related to usage or factors associated with usage. After finding significant correlations between some of these factors, I developed a model of influential factors based on this

survey data to compare with and structure my arguments in relation to the coded interview data (see **Figure 2,** below).

I concluded by relating the survey data-based model, the patterns emerging from the interviews, and the usage statistics from Project LISTEN's server to develop the final model I used to inform the 'themes' section of this study. I used the actual teachers' usage statistics for this final analysis. However, I did not list the actual usage statistics in table 5 in the appendix. This was to ensure the anonymity of teachers in the highly unlikely event that Project LISTEN staff would try to link teacher identities with the usage statistics. In the next section, I describe and discuss the results of this study.

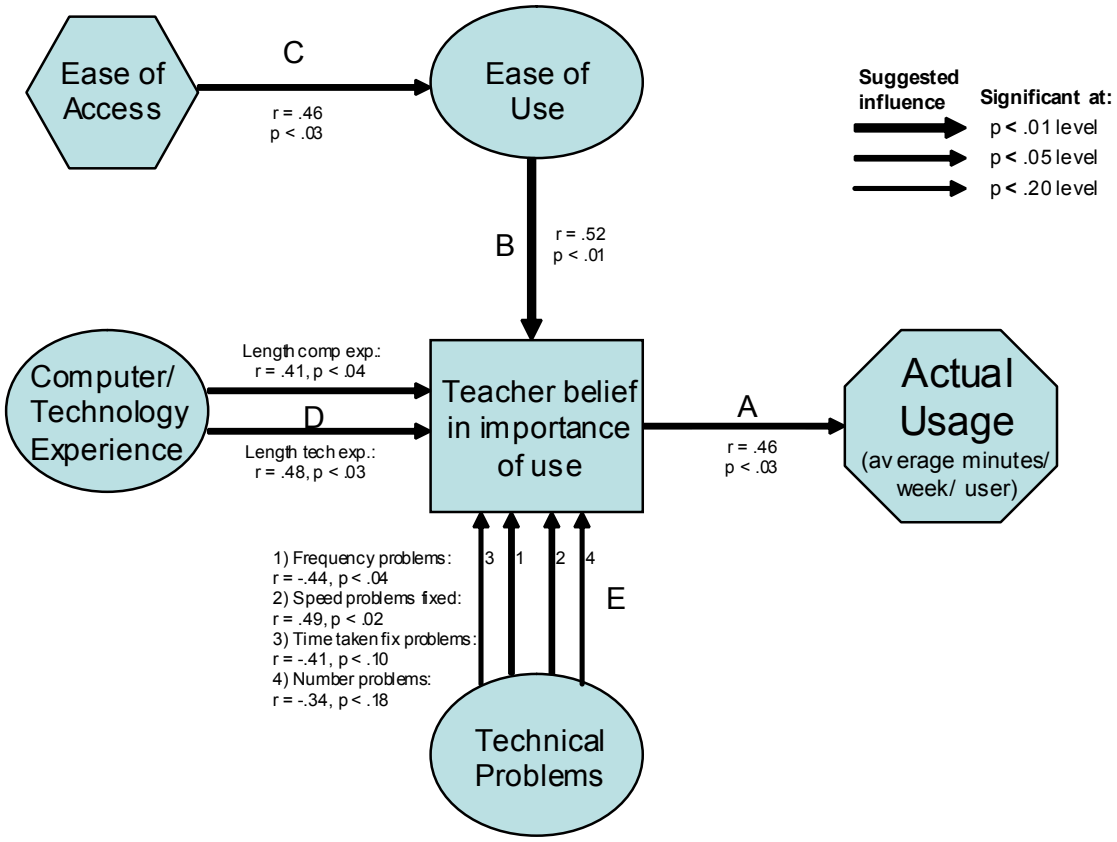

Figure 2: Model of factors relating to teachers' perception of the importance of using the Reading Tutor

("r" represents the correlation coefficient. A correlation coefficient between two variables is found by dividing their covariance by the product of their standard deviations. "p" represents the p-value, or the probability, if the test statistic were really distributed as it would be under a null hypothesis, of observing said test statistic as extreme as or more extreme than the one actually observed.)

Results & Discussion

I will now describe the results from the survey and interviews. I begin by establishing the link between the factor 'importance of use' and usage. I continue by examining the factors that appear to influence 'importance of use.' In each of the following sections, I will use correlations from the survey data and comments from the interview to establish that there is a relationship between the two factors. I will then use survey data correlations, comparison using the interview data, previous research, and argumentation based on reason to argue in favor of a specific direction for that relationship. I will then present alternate explanations. Please refer to **Figure 2** and the capital letters (A-E) on the chart which indicate the relationships I discuss in each section.

I selected the factors I included in the results based on the strength of the correlation from the survey data, compelling comments and patterns of responses made by teachers in the interview data, and suggestions from research literature. The first factor I discuss is teacher belief in the importance of use.

Teacher belief in the importance of using the Reading Tutor

In order to measure teacher belief in the importance of using the RT, I used Likert-scale responses to the survey question "How important do you feel it is to use the RT with your class?" which I refer to as 'importance of use' for the remainder of this paper. I used objectively measured usage data computed by Project LISTEN (as defined in the 'Data Sources' section) for running correlations using the survey data. I argue that 'importance of use' reflected the priority a teacher placed on using the RT.

'Importance of use' was correlated with usage ($r = .46$, $p < .03$) (see **A**, **Figure 2**). I argue that the greater the teacher's perceived value of the RT, the more frequently she would use it. This link is supported by the interview data. In the interviews, teachers expressed belief in the value of RT in several ways. I used interview text I coded as "RT benefits to students," "RT benefits to teachers," and "belief that the RT helps students" as sub-factors relevant to teacher belief. Eleven out of 13 interviewees made comments indicating their belief that the RT helped their students. Here are two examples:

> Overall I've been really impressed with the program. I like it and think it has helped, especially our first graders. (Interview 7)

> I believe it's beneficial. That's why, if I do [the RT] next year, or have the chance, I would probably do it again. (Interview 8)

Teachers' comments covered a variety of perceived benefits that spanned all teacher types and RT settings, suggesting most teachers believed that the RT helped their students. Importantly, none of the interviewees made comments indicating they believed that the RT

did not help their students. However, 5 out of 13 interviewees expressed uncertainty about whether the RT helped their students. Four of the 5 who indicated this uncertainty also indicated belief that it helped their students (Interviewees 8, 10, 11, and 13). One example of this ambiguity comes from Interviews 3 and 10:

> Interviewer: What kind of effect do you think the Reading Tutor has on your student's reading skill?
> Interviewee: I'm not sure, that's what I want to find out. I want to see those statistics … I don't know how to answer that. (Interview 3)

> I feel like I don't know what my kids are doing on the computer, and I don't really know that what they're doing is effective for them … (Interview 10)

I believe that uncertain comments like these suggest that teachers believe the RT may improve student learning, but that they lack authoritative evidence. The 'high usage' teachers were more likely to comment that the RT helped their students, yet they also made more comments expressing ambiguity (see Table 1).

Table 1: Usage relative to number of teachers commenting on 'belief RT works'

Usage by category	Number of teachers commenting on 'belief RT works' (out of 13)	
	Belief RT works	Uncertain
Low	2 (of 3)	1 (of 3)
Medium	5 (of 6)	1 (of 6)
High	4 (of 4)	3 (of 4)

This ambiguity suggests that teachers who are uncertain about RT benefits could be influenced by feedback that would clearly show what kind of effect if any the RT was having on their students' reading skill.

Teachers expressed beliefs that the RT provided a variety of benefits to students including improved reading skill, improved motivation, reading practice, and individualized instruction. All 13 interviewees made comments that the RT helped their students' reading skills, particularly oral reading fluency.

> I felt that it exposed them to some new vocabulary words. And I think it was also very good for their fluency, speed of reading, and sight vocabulary. (Interview 13)

> I think it is helping them to become better readers. I think it is helping them to become more fluent. It's one thing to learn how to decode words and sound it out, it's another to practice it and make it sound fluid. (Interview 7)

12 out of 13 made comments that the RT improved student motivation.

> I know it's made a big difference in the personalities of the kids and their behaviors. I have some, people would say, incorrigible kids in the morning program. And they've really changed their behavior. More sensible, more driven, more purposefully motivated. (Interview 1)

> [My students] look at the clock and say, "when are we going?" I think it's the positive attitude. WE'RE GOING TO THE COMPUTER LAB AND THE READING TUTOR. I mean these kids … they really do enjoy it. (Interview 11)

10 out of 13 commented that the RT gave students significant reading practice.

> [The RT is] just another way for them to get practice, especially with oral fluency because the more they read, the better they get at reading. (Interview 2)

> It's very important for children to read to someone, and some of our children don't really have that someone to read to, so I used [the RT] basically for practice and oral reading. I thought that the children did very well with it. (Interview 13)

6 out of 13, mostly from high-SES schools, made comments that they liked the way the RT offered individualized instruction.

> [The RT] gives them a chance to read at their level, independently, with the Tutor correcting them, rather than a person. I think it's more impersonal, so they don't get as offended and/or embarrassed because it's between the [child and the computer]. No one else hears it. (Interview 4)

> [The RT] provides a very important time for the children to read independently at their own level. [Compared with sustained silent reading] we could not attain that success, we couldn't hold their interest as long as they can be engaged with using the computer. (Interview 9)

Other interesting 'student benefits' a small number of teachers commented upon were improved computer skills, motor skills, speech skills, new content knowledge, and help for students who have anxiety reading in front of others. All of these comments about benefits to student learning as well as the correlation between 'importance of use' and usage

suggest that relationship exists between teacher belief in the importance of using the RT and teacher usage levels.

The link between 'importance of use' and usage is further strengthened by looking at the intersection of usage data and teachers comments on student benefits. Using a matrix intersection comparison in N6 – which shows where a code's set of values intersect with another code's set of values – I noted relationships between usage and the number of teachers who made comments about particular 'student benefits' (see Table 2).

Table 2: Usage relative to number of teachers commenting on 'RT benefits to students'

Usage by category	Number of teachers commenting on 'student benefits' (# out of 13)			
	Reading skill (13)	Motivation (12)	Reading practice (10)	Individualized instruction (6)
Low	3 (of 3)	3 (of 3)	3 (of 3)	1 (of 3)
Medium	6 (of 6)	5 (of 6)	3 (of 6)	3 (of 6)
High	4 (of 4)	4 (of 4)	4 (of 4)	2 (of 4)

Almost all teachers mentioned benefits to reading skill and motivation, though teachers with higher levels of usage more consistently mentioned benefits in reading practice and individualized instruction. This table suggests that while all teachers saw RT benefits to student learning, those with higher usage reported benefits across a wider variety of categories.

Interviewees perceived benefits for themselves as well. Nine out of 13 made comments that they were positively inclined toward the RT or enjoyed using it. 'Easy to use' was a 'teacher benefit' that I will discuss in greater detail in the next section. Four out of 13 mentioned using the RT as a means for informally assessing student reading skill. The two ways teachers mentioned doing this informal assessment was by listening to their

students read and/or by observing information displayed on the RT screen such as story level and time spent reading. However, these 4 interviewees constituted 4 out of the 7 using the RT in a lab-based environment while no teachers from classroom-based RT environments commented on using the RT for informal assessment. This reflects differences in the environment in which the RT is used. Classroom-based RT teachers typically send students back individually to work with the RT or use it as one of many 'centers' that a student rotates through. Computer lab-based RT teachers bring their entire class to the lab and can monitor them by walking around.

A study by Mostow & Beck (to appear) showed that usage differed according to RT setting, with higher average usage levels in lab-based RT settings than in classroom-based ones. However, the study showed that the classes with the two highest usage levels were in classroom-based settings. From this data, Mostow & Beck identify that frequency in use varied between classes, but duration did not vary significantly. Mostow suggests that frequency varied between teachers because teachers decided when and whether students used the RT. He also suggests that duration was influenced by the student, with the student determining how long they were on the RT or the degree to which they spent time-on-task.

The results of this study support Mostow & Beck's conclusions, with higher average levels of usage in lab-based settings at 49.0 (STD 16.9, n = 10) than in classroom-based settings at 30.5 (STD 9.3, n = 9). Specialists had relatively low usage levels at 19.3 (STD 16.4, n = 3). Given Mostow's suggestions and the interview data in this study, I suggest that lab-based settings help structure RT use to be more consistent for a larger number of students and thereby generate higher levels of usage. I suggest that teachers in classroom-based settings may have more control over when and what degree

students can use the RT, which may explain why most classroom-based teachers have lower usage levels than lab-based teachers, yet can have higher potential levels of usage as demonstrated in Mostow & Beck's study. Given these setting differences, I suggest that efforts to influence teacher belief in the importance of using the RT in classroom-based settings may improve total usage, though scheduling efforts in lab-based settings may prove to be more easily manageable and scalable.

Five out of 13 teachers, mostly in classroom-based RT environments, expressed other benefits of the RT such as feeling they had additional instructors in the room or it allowed them a break.

> [Using the RT] is like having four more adults in a classroom. After the first one or two times, they're reading to somebody. It doesn't even phase them. (Interview 6)

> I think the kids enjoy getting out of the room [and going to the computer lab], to be honest. It's just a really nice break … Like I said, I feel guilty but it's a nice break … (Interview 11)

The comment by interviewee 11 suggests that the teacher felt guilty about being able to "take a break" from teaching her students by having them use the RT while she was in the computer lab with them. While not the focus of this study, this comment provides an interesting glimpse into a possible belief that if a teacher is not teaching, they are not doing their job. This belief may reflect an underlying teacher-centric view of pedagogy embedded within the institution of the school. Schofield (1995) suggests that with the incorporation of technology into the classroom, this teacher-centric social and pedagogical

tradition is disrupted, causing confusion of the role of the teacher in a technology-influenced classroom. Zhao & Frank (2003) and Schofield both suggest that the teacher's role becomes more like a facilitator than a lecturer when technology is introduced in certain environments. The teacher's reaction to this change is influenced by their belief in the role of technology in the classroom. As suggested by Schofield and McLaughlin (1993), teacher belief thereby influences a teacher's response to change, in this case technological, including whether or not and the degree to which a teacher uses technology in their classroom.

It is possible to argue that the usage/'importance of use' relationship may go in the opposite direction, that usage might influence a teacher's belief in the importance of the RT. But teachers have a choice in whether or not to use the RT. If teachers did not have a choice – i.e. if they were forced or coerced into using the RT for the duration of the school year – then it would make sense that their use could have influenced their belief in the value of the RT. In this situation, it is conceivable that teachers would not have to think about whether the program improved student learning because they did not choose whether their students used it or not – they had no control over the decision. However, teachers had control over the decision of whether their students used the RT or not in spite of Project LISTEN's proscriptions for daily levels of RT use. The variability in the usage data clearly shows that teachers do not follow those proscriptions. They choose to use the RT or not. I argue that teachers weigh the costs and benefits of using a technology in making their decision to use it or not, and thereby their belief in the importance of using the RT becomes a factors in their decision to use the RT.

I thus argue that teacher belief in the RT influences usage based on the correlation from the survey data, teacher interview comments on 'belief works,' 'student benefits,' and 'teacher benefits,' and supporting research literature. In the next section, I will discuss factors that appear to influence teacher belief in the importance of using the RT.

Factors influencing teacher belief in the importance of using the Reading Tutor

I identified three factors that appeared to influence 'importance of use' – the proxy I used for teacher belief. These three factors from the survey data were: 'ease of use' (and its relationship with 'ease of access'), 'computer/technology experience,' and 'technical problems.' 'Ease of use' refers to answers to the survey question "How easy is it for you to use the RT in your teaching?" The inverse of this question (listed in Table 10 in appendix) about the RT's difficulty of use was designed to see whether there was respondent ambivalence. 'Computer/technology experience' refers to the number of years of experience teachers reported having with computers and (separately) other technology such as overheads, projectors, videos, etc. 'Technical problems' refers to Likert-scale responses teachers gave to the frequency of technical problems and the speed with which problems were fixed as well as the number of problems they listed as experienced in the past month and the length of time it took for those problems to be fixed. Please refer to the survey in the appendix to see the questions asked regarding technical problems (see appendix, Table 10).

As in the previous section, I use survey data correlations and interview comments to establish a relationship. I then use the correlations, comparison using the interview data, and previous research to argue in favor of a specific direction for that relationship in

addition to presenting alternate explanations. Letters B, C, D, & E in **Figure 2** indicate the relationships I discuss in this section. I begin by discussing the relationship between teacher perceived ease of use and teacher belief in the importance of using the RT.

Ease of Use

'Ease of use' was correlated with a teacher's report of 'importance of use' ($r = .52$, $p < .01$) (see **B**, **Figure 2**). Teachers' comments in the interviews also suggested that the RT was easy to use.

> It's easy to incorporate it. Never had a problem having it in the classroom [because] you don't have to oversee it. The students can just take it and run with it. It was easy to work with. It's not difficult having it. (Interview 6)

> Once you show [the students] how to do it one time for the most part they have no problem getting into it. (Interview 7)

Interviewed teachers reporting high levels of ease of use on the survey also tended to make comments about the RT's ease of use in their interviews (see Table 3).

Table 3: 'Ease of use' survey responses relative to number of teachers commenting 'easy to use'

Survey 'ease of use' (Likert scale: 1 low 'ease of use,' 5 high)	# teachers commenting 'easy to use' (9 out of 13)
2	0 (of 1)
3	2 (of 3)
4	3 (of 4)
5	4 (of 5)

The survey and the interview data corroborate one another, suggesting that the survey responses and the interview comments accurately reflected the teacher's belief regarding how easy the RT was to use. Drawing on the strength of qualitative and quantitative data, this comparison shows that both sources – the interviews and the surveys – are accurately getting at teachers' perception of the RT's ease of use and clearly establish a relationship between the two factors.

Existing research supports these comparisons, suggesting that the ease with which a teacher can use a technology influences their view of that technology. Zhao & Frank (2003) point out that teachers value technologies based on their cost-effectiveness: teachers selected computer programs that fit with their practice, required little time to learn, and provided benefits to them and their students. Zhao et al. (2002) discuss the way that a technology's distance from practice influenced the choices teachers made to use different technologies. In both cases, the ease with which teachers can use a technology with their students and in their practice – in other words, its convenience – shapes the value teachers attach to a given technology. Easy-to-use technologies influence teachers' beliefs about which technologies to use.

These comparisons, the correlation between survey 'ease of use' and 'importance of use,' and the research literature suggest that the easier a teacher feels it is to use the RT, the more important they feel it is to use it.

One could make the argument that teacher belief in the importance of the RT influences teacher perceived ease of using the RT. One example might be technologies already-established in schools. It may stand to reason that because a teacher has used a technology for a long period of time, the teacher reports a belief in the technology in order

to justify their long use of it. Another example might be where teachers who believe in a technology overlook inconvenient features and rate it higher in ease of use.

While these explanations are plausible, I believe that a ease or use influences teachers' belief in the importance of use. For example, prior to starting the program, teachers had little experience actually using the RT and thereby had limited personal experience from which to form their beliefs. For example, Interviewee 5 said: "You have to remember I was really skeptical of [the RT] at first. And I'm like 100% for it now." His comment suggests that teachers refined their belief about the RT based on their experience of using it. More importantly, teachers had a choice as to whether they used it. It stands to reason that 'ease of use' served as a form of evidence – *convenience* – that influenced teachers' belief in the importance of the RT. Later in the themes section, I argue that the convenience of the RT is a kind of evidence which teachers use to evaluate the value the teacher places on the RT and thereby help them make the decision of whether to use it.

The above arguments, survey and interview data, and literature support the suggestion that perceived ease of use influences teachers' belief in the importance of using the RT.

Before concluding this section on ease of RT use, it is important to consider the effect **'ease of access'** indirectly has on 'ease of use' (see **C**, **Figure 2**). 'Ease of access' refers to the teachers' Likert scale survey responses to the question "How easy is it to get access to the RT when you want to use it?" 'Ease of access' correlated with survey 'ease of use' ($r = .46$, $p < .03$). In order to use the RT, teachers need access to computers. Without easy access to computers with the RT, teachers cannot use the program frequently or as desired. Both classroom-based and lab-based RT environments had problems with access

to computers. For example, though classroom-based RT teachers could use the computers when they wanted during the day (provided the computers were working), they could only put a few students on at a time. Lab-based RT teachers could only go to the lab at scheduled times, but were able to have their entire class using the RT at the same time and, if there were extra computers, move students to other computers should they experience a technical problem.

Both RT environments had identical distributions of survey responses for 'ease of access,' though lab-based RT teachers reported slightly higher survey 'ease of use.' I believe this difference may relate to the effect technical problems have on classroom-based RT environments. First, lab-based teachers typically had the assistance of a dedicated computer assistant. Classroom-based teachers did not. Second, because they had extra computers, lab-based teachers could move a student from a computer that crashed to another that worked properly. Classroom-based teachers had between two and four computers in their room so if one broke down, they had no alternatives. Third, lab-based teachers could respond to technical problems because all students were occupied using the RTs. Classroom teachers would have to interrupt their teaching in order to deal with problems. These differences between RT environments suggest that ability to respond to technical problems may be related to school SES, as classroom-based RT environments were largely in low-SES schools while lab-based ones were in medium- or high-SES schools.

This difference being noted, both the survey data and interview data supported the notion that 'ease of access' influenced survey 'ease of use.' For example, teachers who

reported high 'ease of access' also tended to make 'easy to use' comments about the RT (see Table 4).

Table 4: 'Ease of access' survey responses relative to number of teachers commenting on 'easy to use'

Survey 'ease of access' (Likert scale: 1 low 'ease of access,' 5 high)	# of teachers commenting on 'easy to use' (9 out of 13)
2	0 (of 1)
3	2 (of 3)
4	2 (of 4)
5	5 (of 5)

The table data suggests that perceived ease of access influences perceived ease of use. Thus, the correlation and comparisons between the survey and interviews suggest that 'ease of access' influences 'ease of use.'

In the next section, I describe the relationship between technical problems and teacher belief in the importance of using the RT.

Technology experience

The **amount of computer and instructional technology experience** – such as overheads, slides, television, etc. – teachers possessed seems to influence teacher belief in the RT (see **D**, **Figure 2**). Both 'computer experience length' ($r = .44$, $p < .04$) and 'instructional technology length' ($r = .48$, $p < .03$) – the two components of 'computer/technology experience' – were correlated with 'importance of use.'

Interestingly, there was *not* a significant correlation between amount of experience using the RT and 'importance of use.' One explanation may come from the composition of

the sample. The participant group was comprised of teachers who had only been using the RT for a few months to a few years: over 40% of the 22 teachers had been using the RT for less than a year and only one teacher had used it for more than four years. This amount of experience with the RT is quite different from the significant amount of time they had spent with computers and other instructional technologies. Teachers averaged 7.1 (STD 3.9) years of computer experience and 11.2 (STD 7.0) years of technology experience – significantly higher than the average 2.1 (STD 1.7) years of RT experience.

Furthermore, teacher use of the RT is determined by whether or not a school retains the RT from year to year. This sample included teachers currently using the RT, which did not account for teachers who may have decided to stop using it. If the study included these teachers, it may have strengthened the correlation between years using the RT and teachers' views of its importance of use.

I did not ask specific questions during the interviews about the amount of computer or technical experience teachers possessed. However, a teacher with high usage and high 'importance of use' made comments that suggested her interest and experience with technology made them value the RT more.

> I think there's a lot to do with technology in elementary education, and I wanted to learn about the [RT] program …basically because I have an interest in computers and a lot of teachers have no desire to even touch the computers … I encourage technology, and I encourage [the students] not to be afraid of clicking the wrong buttons. (Interview 11)

I believe that teachers who possessed an ability to troubleshoot, an understanding of limits and benefits of current technology, and an interest in using that technology to improve

student learning appeared to value the RT more than their peers who did not express the same degree of technology interest and/or experience. An example of this idea is Interviewee 11 who had the highest level of usage of all interviewed and surveyed teachers. Interviewee 11 also administered the computer lab, thus allowing her to influence the lab's schedule, which programs were incorporated into the computer lab, and administrative policy relating to technology.

It does not stand to reason that belief in the importance of the RT would directly influence the amount of computer or technical experience the teachers reported. While teachers using the RT may have gained greater confidence using technology with their students, thereby influencing their report of 'computer/technology experience,' their report was in number of years, a fairly objective measure less susceptible to misreport.

One way in which belief in the importance of technology could influence computer experience is by motivating a teacher to gain experience with computers or other technology. Teachers with a strong belief in the importance of using technology and/or computers might have led them have a strong interest in educational technology. Because of this interest they may have sought out experience using technology in their teaching practice. However, given the fact that measures of 'computer/technology experience' and belief in the importance of the RT were taken at one point in time, it is inconceivable that 'importance of use' influenced report of 'computer/technology experience.'

Computer and technology experience was also weakly correlated with perceived ease of use ($r = .343$, $p < .12$; $r = .417$, $p < .06$, respectively). I did not include this relationship in the model I developed earlier because the correlations were not significant at the $p < .05$ level and comments made by teachers in the interviews did not explicitly

support this assumption. However, these correlations are suggestive and, given a larger sample size, would be useful to examine in future studies because of the close link between 'importance of use' and 'ease of use' as well as attention by Schofield (1995) to computer experience and perception of technology.

The survey data correlation and the interview comments above suggest other avenues for future research. Three possible directions would include examining in greater detail 1) whether experience with technology makes teachers believe more in the importance of using technology, 2) whether interest in computers influences 'importance of use' more than experience with other technology, and 3) whether specialized training can increase a teacher's belief of the importance of using technology regardless of prior experience.

Existing literature supports the position that technology experience influences a teacher's belief in and facility with technology. Schofield's (1995) work also identified teacher experience with computers as influential to whether a new technology is successfully implemented in a school. Zhao et al. (2002) explicitly identify "technology proficiency" as a factor influencing the successful introduction and implementation of technology into a classroom environment. More importantly as relates to teacher belief, Zhao et al. also stressed the importance of the compatibility between the teacher's pedagogical beliefs and the technology being introduced. In this manner, computer/technology experience can help ease the incorporation of new technology into teaching practice by helping teachers adapt to new technologies due to their experience with older ones.

The correlation, the literature, and the above teacher comments suggest that teachers' experience with computers and technology influences their belief in the importance of using the RT. In the next section, I describe the relationship between perceived technical problems and teacher belief in the importance of using the RT.

Technical problems

'Technical problems' was correlated with 'importance of use' for two measures – negatively with frequency of technical problems ($r = -.44$, $p < .04$) and positively with speed problems were fixed ($r = .49$, $p < .02$). 'Technical problems' was negatively correlated with teacher reported 'time taken to fix problems' and 'number of problems experienced per month' (see **E**, **Figure 2**). These correlations suggest that teachers who reported more technical problems also reported less of a belief in the importance of using the RT. The comments from the interviews support this link between 'technical problems' and 'importance of use.'

Thirteen out of 13 teachers mentioned technical problems during their interviews. Ten out of 13 mentioned problems I coded as "general," which referred to glitches or problems teachers encountered frequently when using the RT. I also coded for four specific types of problems that came up frequently: computer crashes (5 of 13), headset or microphone problems (8 out of 13), leveling problems (6 out of 13) – where the RT selected stories far above or below the child's reading level – and repeated stories (3 out of 13). Other reported problems included the tutor not being able to hear the student, a student's voice "echoing" in the machine, the tutor going on to the next sentence too quickly, and software conflicts between the RT and other programs.

In the interviews, teachers commented that technical problems caused them and their students frustration when using the RT. While technical problems influenced every teacher to a certain degree, some expressed more frustration than others.

> It seems that we've had a lot of [technical problems] and that's actually pulled away from our using [the RT] this year. I can't take time out from working with the other kids to go back and fuss with the computer, which I don't really know that much about to begin with, so I don't want to go poking in, prodding in something that I don't know very much about. (Interview 10)

> Any time the tutor breaks down, which this year has been every other MINUTE, it interrupts the flow of my teaching. (Interview 12)

> Certain glitches have to be worked out of the program [because they] just cause frustration, especially when you don't know how to fix it. (Interview 13)

Some teachers were particularly vehement in expressing their dissatisfaction with technical problems. Interviewee 12 talked about how she used the RT "religiously" before the technical problems this year caused her to choose to not use the program. These comments considered in tandem with the correlations suggest that teacher perception of technical problems influence their belief in the importance of using the RT.

Strangely enough, there was no correlation in the survey data between technical problems and RT setting, suggesting that perception of technical problems influenced all environments to a similar degree. There also was no correlation between perception of technical problems and usage, another curious finding given that technical problems can prevent usage entirely when they cause a computer to crash or the RT program not to work.

However, perception of technical problems is unlikely to directly influence usage if you accept the assumption that it is the teacher's belief in the importance of using the RT – in other words, the teacher's *choice* to use it or not – that influences usage. From this point of view, frustration arising from technical problems, even if surmountable, influences the value a teacher places on the RT and thereby influences their usage.

One could argue that teacher belief in the importance of using the RT could influence teacher report of technical problems. For example, a teacher who believed in the RT may overlook frequent technical problems given the value they feel they derive from using the program. However, I believe that the earlier teacher comments and the following studies suggest that the more compelling argument is the reverse – that technical problems influence teacher belief in the importance of using the RT.

Research supports the notion that technical problems influence whether a teacher sticks with using a given educational technology. Zhao et al. (2002) point out how the greater the dependence of a technology upon technical resources, the more difficult it is to successfully incorporate the technology into teaching practice. Schofield (1995) talks about the frustration experienced by teachers who deal with frequent technical problems which cause decreased time for instruction, reduced sense of competence, and strain student perception of teacher authority.

Thus, the negative correlations between 'technical problems' and 'importance of use' combined with previous literature and interview comments about frustration with technical problems suggests that teachers who perceive significant technical problems tend to believe less in the importance of using the RT.

In the results and discussion section I discussed the findings of the study and argued that teacher belief in the importance of the RT influences usage of the RT. I also argued that perceived ease of use, technology experience, and perceived technical problems influenced teacher belief in the importance of using the RT. I based these arguments on correlations from the survey data, patterns of interview comments, and previous research.

In the next section I discuss themes that cut across these factors and help tell the story behind the relationship between teacher perception and usage.

Themes

In this section I discuss four themes that cut across the factors described in the results and discussion section and help tell the story behind the relationship between teacher perception and usage. The themes are technology **convenience**, **competition** between educational practices, **experience** and/or interest in technology, and available **data** and its priority in evaluation. These themes can be useful for academics, software designers, policy makers, administrators, and teachers for evaluating new technology by posing them as questions:

1. How convenient is a given educational technology? How well does it fit into current teaching practices?
2. How much will this educational technology compete with existing practices, technologies, and teacher priorities? What need does this technology meet?
3. How much experience do teachers need to use this technology? Do teachers need training to use it most effectively? How will teachers with technology experience view this technology?
4. What kinds of data would be most compelling to teachers? What kinds of data are currently available to teachers about the technology and its effects?

In the following sections I draw on the survey correlations, interview comments, and research literature to suggest ways in which these themes influence teacher perception and usage of the RT. I begin by discussing the influence a technology's degree of convenience has on teacher perception of that technology and its use.

Technology's degree of convenience

In order to prevent confusion, I start by drawing a distinction between the survey data 'ease of use' from the results section and 'convenience.' Survey ease of use relates to how easy the product is to use in and of itself, while convenience is meant to also account for the circumstances in which the technology is used. Thus, convenience has to do with not only the ease of the technology, but also how the technology fits into the teacher's practice and working environment. In their consideration of teacher technology use in a Michigan study, Zhao & Frank (2003) use an "ecological metaphor" – likening technology to species in an ecosystem – to describe their finding that the most frequently used technologies were simple ones: email, telephone, computers in the classroom (in that order). "This finding is consistent with an ecological metaphor in which simpler technologies requiring little adjustment to existing practices are more frequently used." In the interviews, teachers with high usage levels made 'easy to use' comments that implied they found the RT convenient to use. The following quotes come from 2 teachers with medium to high usage levels:

> It's easy to incorporate it. [I] never had a problem having it in the classroom. (Interview 6)

> [The RT] is self-directed so the kids can just get on and use it. Once they're on, unless there's a problem, I just walk around and watch. It is very easy for the kids to understand. (Interview 8)

These teachers felt that the RT was easy to incorporate and use with their students, two aspects I would label as convenient. To borrow from Zhao & Frank, teachers are concerned about reducing the costs associated with teaching – time, effort, new technologies to learn – while getting the most benefit they can from the technology.

The following comments by teachers with low- to low/medium-usage lend support to this notion that easy-to-use, low-cost effective instructional technologies go hand in hand in convincing a teacher of the value of that technology.

> I think it is difficult because [teachers] have a curriculum that they have to get into the school day, and [using the RT]… takes more effort [from] the teachers … I think it requires 'above and beyond' on their part. (Interview 7)

> We have pulled away from using [the RT] because we had two [computers] that kept shutting down, and I have fifty million things to do. I am not good at calling them to say there's something wrong with the computers … (Interview 10)

I believe these comments demonstrate that technical problems and poor fit with classroom practices can detract from the convenience of a technology and thereby negatively affect teacher perception of that technology. Even though the RT is perceived by most teachers surveyed (14 of 22) as being easy to use (4 or 5 on Likert scale), the burden of additional effort and time created by its use influences a teacher's perception of its convenience as

suggested by interviewee 7's comment. Zhao et al. (2002) provide another way to look at convenience by examining the costs associated with technology use.

Zhao et al. (2002) see the 'distance from' existing technology and practice of new technology (i.e. departure from the status quo) and the 'dependence on' existing technology and practice of new technology (i.e. reliance on technology or people) as a key factor influencing whether a new innovation is used. Evaluating the RT along these lines, I would categorize the RT as being slightly distant from existing technology and moderately distant from existing practice, yet significantly dependent on technology and people. Thus, while teachers find the RT easy to use for supplemental instruction, it is not tailored to fit their instructional practices, technical problems with the RT cause difficulties, and the RT is highly dependent on the computing resources of the school district, the personnel of Project LISTEN, and to a lesser extent technical support services and the administration of a school or district. In short, the RT is easy to use, but costly to support, which can lead to teacher inconvenience and frustration. Thus, a teacher's perception of the RT's convenience is impacted by technical problems, support required, and the fit of the RT into the teachers' practices. This, in turn, influences the importance a teacher places on using the RT and, I argue, thereby influences their use of the RT.

I think convenience has served as a means by which teachers value the RT. This may be one reason for the association between 'ease of use' and usage ($r = .49$, $p < .02$). 'Ease of use,' through its relationship to convenience, influences the way a teacher judges the RT. Thus, convenience serves as a marker or kind of evidence by which teachers evaluate, prioritize, and use (or do not use) the RT. In the next section, I discuss the

influence competition from other educational technologies, practices, and priorities has on teacher perception and use of the RT.

Competition from other educational priorities and practices

Teachers face a variety of pressures that influence their valuation of and decision to use or not to use one instructional practice over another. These competing priorities are no different for teachers' valuation and use of educational technology. Zhao at al. (2002) discussed the competition for technological resources and social support that some teachers faced in trying to implement new instructional technologies. Zhao & Frank (2003) used an ecological metaphor to help make sense of the confusion caused by the introduction of a new technology into a school. They discuss the competition between different kinds of instructional technologies, likening them to competing species that influence and are influenced by their environment.

> It seems evident that, like organisms in an ecosystem, teachers use computers in ways that address their most direct needs, bring them maximal benefits, do not demand excessive time to learn, and do not require them to reorganize their current teaching practices. Thus teachers' choices of computer activities minimize costs (Zhao & Frank, 2003)

Teachers made comments suggesting the competition between various instructional practices compounded by time constraints.

> I don't see a necessity [to use the RT] longer than [20 minutes] because I don't want it to get to a point where it takes away from the instruction. (Interview 2)

> Scheduling is the most difficult [problem], probably for any elementary school: to find the time to do one additional thing. (Interview 4)

> Sometimes [the problem is] just finding the time in the day. Sometimes you get in such a rush [that] it's the first thing that you drop. (Interview 6)

> For the past two years my kids have been doing the RT … instead of reading quietly in the classroom. (Interview 8)

These comments show different priorities and ways of thinking about the RT and its effect on teacher practices. The comments by these interviewees describe the influence time pressures have on their decisions to use the RT, the value they place on traditional instruction, and the way their priorities determine whether they use the RT.

I believe this competition manifested itself clearly in teachers' responses to whether they had a software preference or not. There was a correlation between usage and whether teachers preferred another software program over the RT ($r = -.63$, $p < .02$). I believe this relationship between a software preference and usage comes from teachers weighing the costs and benefits provided by differing practices, availability of competing pieces of software, time constraints, and other environmental factors. Teachers develop a preference for a piece of software after deciding which software better meets their needs. For this reason I believe that 'software preference' is not a causal factor influencing usage for two reasons. First, I only have the survey correlation to support this point. Second and more important, I believe software preference represents the end result of a teacher weighing the costs and benefits of one software program over another. This decision is based upon the teacher's belief in the value of one program over another given their

priorities for improving student learning. Thus, I argue that 'software preference' is a corollary reflecting a teacher's belief as to which practice is more important. Do I use the RT or do I use a competing product? Which works? Which is more convenient to use?

Teachers did in fact weigh the costs and benefits of one program over another in selecting a preference. For example teachers who preferred other software, in this case the program called *Essential Skills*, wrote the following on their surveys:

> [Teacher prefers] Essential skills. [because] Graphics, organization and record keeping. (Interview 4)

> [Teacher prefers] Essential skills. [because] Very child friendly, doesn't crash, correlates to our reading curriculum, very colorful, challenging, and computer print outs of child's progress. (Questionnaire 7)

> [Teacher prefers] Essential skills. [because] The children enjoy it, it's a game setting, they move through different areas of reading skills. (Phonemic Awareness, Phonics, sight words, etc.) (Questionnaire 8)

These comments show us that teachers weigh the pros and cons of competing software packages and form beliefs about them accordingly. Thus, whether this process is explicitly conscious or more internalized, teachers competitively evaluate whether or not to use a technology in their instructional practices.

One of the most important factors influencing the competitiveness of the RT is technical problems. Technical problems increase the cost of using the RT. Technical problems are costly in terms of time for teachers, tech support staff, and Project LISTEN staff. They also are costly in harder-to-measure ways, causing frustration and increased

difficulty for teachers and their students. The following comment shows the cost in time and frustration for one teacher who uses the RT:

> You're not sure whether it's the computer or whether it's the program. You have them switch computers. Sometimes the same thing keeps happening. You're wasting your short time down there … trying to figure out what the problem is. (Interview 13)

In the competition for a teacher's attention, belief in, and selection of one educational technology over another, I believe technical problems are the most important cost associated with the RT.

In the next section, I discuss the role experience and interest can play in teacher perception and use of the RT.

Experience and/or interest with technology

Experience and training influence the way a teacher values and chooses between instructional practices. Unlike convenience or competition, which serve as a kind of data which the teacher weighs in making a decision, experience acts as a filter or lens through which teachers evaluate the data they have about competing instructional practices.

As the survey data suggests, a teacher's experience with computers and instructional technology influences their perception of the value of a new technology. Teachers draw upon their experience to help assess whether or not a new technology is worth using and to what degree. Teachers with more 'computer/technology experience' tended to believe in the importance of using the RT more and had higher levels of usage. Though I did not explicitly study the influence technology interest has on belief, I believe that technology

interest also influences a teacher's belief in the importance of using a new technology. The following teacher's comment reflects this notion:

> I think there's a lot to do with technology in elementary education, and I wanted to learn about the program. So, it ended up in my room that way … basically because I have an interest for computers and a lot of teachers have no desire to even touch the computers, that hobby just kind of came into play. (Interview 11)

On the other hand, I believe a lack of experience, interest, or training can influence a teacher's perception of the value of the RT. The following comment is from a teacher with a low level of usage:

> If I took [using the RT] more seriously and if maybe I had had more training with the computer and felt that it really [helped] … I feel like I don't control [the RT] enough … I feel like I don't know what my kids are doing on the computer, and I don't really know that what they're doing is effective for them … (Interview 10)

Teachers with an explicit interest or training in reading education also tended to be more interested in the RT.

> I was working on my Master's as a reading specialist. After seeing [the RT] and knowing what I was learning in my Master's program, [I saw that what] I'm learning is what these kids are using on [the] computer. And that's what made my decision – I want this – because they were using the same strategies I was learning to use with students so that's why I made my decision: I want to stick with it as long as they keep it here. (Interview 6)

The benefits of additional training in reading education also afforded reading specialists a more focused perspective to evaluate the RT's instructional and infrastructural strengths and weaknesses in great detail. Some of the reading specialists provided targeted, insightful suggestions for improvements for RT design and support. I have included these suggestions in the appendix (see Table 11).

Higher levels of interest and experience can both positively and negatively influence a teacher's belief in the RT. However, I believe the feedback provided by these teachers is valuable for critically assessing and improving the design of and service behind the RT. In this way, experience shapes a teacher's perspective, but also has the potential to influence the fit of the technology itself.

In the next section, I describe the last theme and its relationship to teacher perception and use of the RT.

Available data and its priority in evaluation

Teachers draw upon different kinds of evidence or data when making decisions about the technological or instructional practices they use and to what degree. As the following comment shows, teachers assess, weigh the benefits, and choose one practice or technology over another based on the evidence available to them:

> I had to sacrifice some things to use the RT … It was basically sitting down, looking at "do I want the children to have a twenty minute … independent reading period versus calendar time," and I thought the balance was worth the trade-off. (Interview 9)

Teachers make decisions, explicitly or implicitly, based on the evidence that they have and can reasonably consider within limited time periods. As discussed in earlier in this section, convenience and competition are examples of kinds of data that teachers use in evaluating instructional technology. Their experience, interests, and training influence their evaluation of the data. All of these are important factors to consider given the goals, constraints, and pressures of teachers' work.

Thus teachers weigh the costs and benefits of one practice or technology over another. Teachers' reactions to new technology are hard to predict by educational technology developers due to the variability from teacher to teacher in the degree to which they reflect, the time and effort they can take, and the background experience they bring to a decision to use technology. Teachers' perceptions influence their belief in the importance of using a given technology, their choice to use a technology, and their subsequent usage.

So what kinds of data do teachers use in evaluating the RT?

Convenience, **competition**, and **technical problems** are all key factors used to weigh a piece of educational technology like the RT. Another source that appeared to influence teacher belief was perception of **direct results**. Certain teachers cited the success they saw some of their students having with the RT as the reason they used it.

> Who influenced me? … seeing the success of my children that first year. I had five children in the program the first year out of my classroom. Two just took off in reading, and out of those five, [only] one remained in remedial reading. That's pretty good odds. *So to see the success that [my] children had with it, I had to introduce it to my entire class. I had to do that.* (Interview 9) [My italics]

Interviewee: I was really skeptical of [the RT] at first. And I'm 100% for it now …

Interviewer: Is there anything in particular that won you over?

Interviewee: *Seeing the kids doing it*. (Interview 5) [My italics]

Other potential sources of data come from social influence, research, and authority. However, teachers in this study did not appear to be influenced much by these sources. In the interviews I explicitly asked teachers about the influence their peers, school administration, Project LISTEN staff, and any key individuals may have had on their decision to use or way they use the RT. Almost all teachers reported that others did not influence their decision to use or way of using the RT. Studies by Mostow et al. (2002, 2002b, 2003) have shown significant effect sizes relating to the RT's influence on student's reading ability. None of the teachers I interviewed mentioned the research findings or the research basis behind the RT as a reason they used it. I can think of two explanations for this finding: 1) teachers are not being provided with research data and/or 2) teachers do not prioritize this kind of data, instead drawing upon other kinds of 'evidence' such as personal experience and/or seeing their students' success.

One solution to the problems posed by both explanations is to provide teachers with relevant research data in a form that is convincing and relevant to them. I argue that in the absence of this form of data, teachers will use whatever relevant data is available to them in making their decision about whether to use the RT. This decision making process can lead to teachers judging new technologies based on data that, while influential and in some ways important, may not be as important as other data. In the case of the RT, the lack of engaging graphics and a slick interface as well as the experimental status of the software

may suggest to teachers that the program is incomplete or 'still-in-process' instead of a professional tool that adds value to their work. Thus, even though the function of the RT – to improve students' reading skill – is well supported by research, the RT's form may influence teachers' usage and valuation of it.

Convenience and competition as well as the look and feel of the RT thus serve as surrogates to research and outcome-based evidence that the RT works. Teachers may have to choose whether to use the RT based on the look and feel of it because they do not receive data such as pre-and-post test scores demonstrating that their children were making significant reading gains because of the RT. The lack of relevant data in a form that is convenient and comprehensible is a significant concern if Project LISTEN wants to influence teacher belief in the RT. The following comments by teachers demonstrate how the lack of authoritative data can cause doubt or weaken belief in the importance of using the RT:

> I know it's showing improvement, I just don't have data to say exactly what. (Interview 2)

> I haven't seen [the students'] data. "Kids who read this many more times a week improve so much more than people who don't read as much" … I'd really like to see the data from my kids this year. (Interview 11)

This brings up two points: 1) a lack of data available to RT teachers and 2) a failure to situate learning gains as they relate to each teacher's students. I believe even if data showing that the RT produced significant gains in controlled studies were clearly presented to teachers, teachers would not buy-in as much as if they received data showing the way the

RT directly affected their own students' reading skill. By providing data from rigorous research as well as data about their students, I believe teachers would have the opportunity to link the strength of research-based evidence with the compelling relevance of data about their students' gains and their experience of working with the RT. Providing solid data relevant to the teachers' perspective also brings the teacher into the evaluation process, an essential step given the central role teachers play in their students' education. In this way, the RT can serve as a tool for teachers to assess student progress, remediate difficulties, and/or build particular reading skills, thus integrating the program more fully into teachers' practices and increasing their ownership of and investment in the program. In this way, it becomes possible to creatively use data to increase teachers' belief in the value of the RT and, as this study suggests, thereby increase their use of it.

In the next section I conclude this thesis by summing up the study, making recommendations, pointing out limitations, and suggesting avenues of future research.

Conclusion

This study looked at factors influencing teacher perception and use of Project LISTEN's Reading Tutor (RT) in an effort to suggest useful factors and themes for considering teacher perception and use of other educational technologies. I used interview and survey techniques to examine teachers' perception of the RT and its relationship with their usage. I found in both the interviews and survey data that teachers' belief in the importance of using the RT appeared to influence their usage of the RT. I also found that three key factors that appeared to influence teacher belief in the importance of using of the

RT – perceived ease of use, teachers' experience with computers and instructional technology, and perceived technical problems.

My analysis of these factors suggested four themes that influence the way teachers evaluate and use the RT – technology's degree of *convenience*, *competition* from other educational priorities and practices, *experience* and/or interest with technology, and *data available* to teachers and the way teachers evaluate that data. I now suggest recommendations for influencing teacher perception of the RT and their use of it.

Recommendations

In order to influence teachers' usage of the RT, it is important to influence their perception of the RT. The four themes I identified in this study serve as useful starting points for considering how to influence teachers' belief in the RT.

Increasing the convenience associated with using the RT will help to raise teachers' valuation of the program and help it win the competition between it and other instructional programs. The first step would be to increase Project LISTEN's capacity for handling technical problems. This factor seemed to be the single largest cause of teacher frustration with the RT. While most interviewed teachers reported positively on support provided by Project LISTEN's field staff, they were less enthusiastic about the state of the RT when it arrived at their school. A second step would be to refine the design of the RT to make it more child-friendly and add more interesting graphics to make the RT attractive and interesting to children. This would help to make it easier to use the RT while also making it attractive to prospective teachers as well as maintaining young student interest.

Dealing with the variability of teachers' experience is another way to try to influence teachers' belief in the RT. A formal initial and ongoing training program would explicitly educate teachers about the capabilities of the tutor, ways other teachers use it, and ways to interpret the data it provides to help with their teaching. This program could help to improve teachers' understanding of the RT and influence their beliefs about it. Teachers experienced with the RT could be hired to run the training sessions. Experienced teachers could share first-hand knowledge to new users while helping Project LISTEN by outsourcing the training functions and developing a community of practitioners. In particular, experienced teachers could mentor teachers with less experience in the same school and serve as key contact people for coordinating technical support, feedback to Project LISTEN, and disseminating student test results from Project LISTEN. For example, one low-cost solution might be to incorporate a Listserve on which teachers can share and discuss strategies for using the RT. Thus, through increased training and the development of collaborative relationships between teachers, I believe Project LISTEN could influence teacher belief in the RT and thereby improve usage.

Finally, Project LISTEN could develop a mechanism to conveniently provide data relevant to the teachers' concerns and show those teachers how to use that data to improve their teaching practice. This mechanism for providing data could be designed directly into the RT itself, disseminated through the Project LISTEN web-based Teacher Tool, or passed through the field support staff by providing testing results of student progress. Quarterly or more frequent student reports would help teachers with parent conferences and provide data which teachers could use to alter their instruction to better fit their students' needs. Furthermore, targeted data about comprehension, fluency, and other

components of reading can help teachers better assess where their students need to work. A record keeping function that displayed student progress to both teachers and students would be helpful in showing student progress to both interested parties. Project LISTEN may also want to make cosmetic changes to improve the appearance and interface of the tutor to help maintain young student interest and to attract new teachers to the program. Most importantly, however, Project LISTEN must ensure the data would be easily accessible and clearly communicated in order for it to be useful to teachers, to influence their belief in the tutor, and thereby increase their usage.

In addition to these recommendations, I have included a list of suggestions from myself and teachers I interviewed to offer Project LISTEN staff ideas which they may want to incorporate into the RT (see appendix, Table 11). I also belief this thesis may be useful to academics, educational software designers, education policymakers, school administrators, and teachers interested in better understanding the perception and use of educational technology.

Academics interested in educational technology usage can benefit from the support this article lends to prior research suggesting teacher belief in the value of a technology influences their usage of it as well as the influence a teacher has over student use of technology. Educational software designers can benefit from this article's consideration of teacher influence on student usage. In developing technologies that are used in schools, designers and advocates will want to consider the central role a teacher plays in determining what educational technologies are used by their students and to what degree within the context of the classroom. Education policymakers can benefit from this thesis' consideration of the speed with which technology is incorporated into schools as well as

the importance of considering teachers as a key stakeholder influencing student use of new educational technologies. School administrators can benefit from this thesis' findings when considering new technologies to possibly incorporate into their school. Technologies that fit well into existing practices of the schools, provide teachers with useful, reliable information about student learning, and come to the school well-designed and well-supported will more likely be accepted by teachers and thereby used by students. Teachers can benefit from reading this thesis by more explicitly understanding factors that influence their valuation of new educational technologies and to focus data that a new technology effectively improves student learning. Also, teachers can get a sense from the thesis of the problems other teachers face, how those teachers handle the problems, and see new ways of thinking about how evaluate, incorporate, and use new educational technologies.

Study limitations

While I believe this study successfully accomplished its goal to illuminate factors influencing teacher perception and use of an educational technology, it is not without its limitations. I failed to include multiple measures of teacher belief and include interview questions that directly probed this factor. Another limitation is the limited generalizability of the study results. As I was looking only at one technology – the Reading Tutor – the findings from this study may have limited application to other educational technologies. However, limiting the sample to only the Reading Tutor allowed me to keep differences in educational technology constant while I analyzed potential factors influencing the teacher belief in the importance of the RT. This detailed analysis could allow other researchers to

look for similar factors influencing teacher perception and use of other educational technologies.

Another limitation is that while I argue that perceived ease of use influences teacher belief in the importance of use, the relationship between the two is a close one. I was not able to thoroughly disentangle the relationship between those two factors, which may mean that ease of use could be influenced by teacher belief in the importance of use or that the two are being influenced by a third variable not covered in this study.

This study focused on teachers' perception and their beliefs regarding the RT and its usage, and does not accurately account for the actual practices teachers engage in aside from the computed measures of usage. Thus the study is biased toward a belief-centered perspective, as opposed to a behavior-centered one, and may fail to explain real practice. However, I believe future study from these two perspectives may help elucidate the complex interactions between perceived ease of use and belief in the importance of use as they relate to educational technology usage. Rather than one influencing the other, they both may operate on usage directly and indirectly depending upon the circumstances in which educational technology is used.

Future research ideas

I believe three topics raised in this study would be useful to study further. The first topic relates to retention of the RT from year to year. The survey data showed some interesting correlations between whether a school retained the RT and teacher report of technical problems such as frequency of technical problems ($r = -.35$, $p < .11$), speed with which problems were fixed ($r = .39$, $p < .07$), number of technical problems ($r = -.52$, p

< .02), and time taken to fix problems ($r = -.40$, $p < .11$). This suggests that technical problems may influence school retention of the RT. Retention was lowest for high- and medium-SES schools, suggesting that competition from other priorities in higher-SES schools and lack of computing resources in lower-SES schools may explain part of this relationship. One future research direction of value would be to explicitly study what factors influence retention of the RT from year to year.

The second topic relates to indicators of teacher belief in the RT and, by extension, other educational technologies. Many of the factors I initially thought would explain usage (listed in Table 7 of the appendix) proved to be of little use during my analysis of both the survey and transcript data. I included the 'importance of use' question on the survey as a general measure of a teacher's attitude toward or belief in the RT without considering the complexities of the question. I could improve the validity of this study by using multiple questions assessing importance of belief to make sure the teachers were consistent in answers. I could also ask specific interview or survey questions to get at the reasons behind why a teacher feels (or does not feel) it is important to use the RT. This research would help clarify which aspects of importance of use influence the relationship between teacher belief and usage.

The third topic would be to explore in greater depth the relationship between ease of use and usage. In this study I looked at teacher perception and the influence teacher belief in the RT has on usage. I believe this argument is the most compelling one for describing initial teacher acceptance, buy-in, and subsequent usage. However for educational technologies already embedded within a set of school practices, a different argument could be made that the more convenient a technology, the more a teacher may

use it. In this way, routine could drive usage which in turn could influence belief. Research into this topic would help clarify these concerns related to usage.

Conclusion

This study contributes to academic literature by supporting and clarifying previous research findings that teacher belief in the importance or value of a piece of technology influences objectively measured usage. Teacher belief in the importance of an educational technology matters when considering the degree to which that new technology is used. Furthermore, major strength of this study is that it used both quantitative and qualitative methods to examine these questions relating to teacher belief in a technology's importance and usage. The use of both methods lends strength to the conclusions of this study because they triangulated different data sources and came up with similar results. Finally, this study contributed to the literature about the role of the teacher in the classroom, suggesting that educational technology designers, policymakers, and administrators need to consider the influence a teacher will have on the degree to which students will utilize new educational technology given the context of our current education system.

APPENDICES

Table 5: 2003-2004 usage statistics and categorized usage

(Usage = average minutes per week per user)

Usage Statistics	
Minimum / Maximum	6.2 / 75.4
Mean (Standard deviation)	37.4 (17.7)
Cutoff: Low-Medium	29.5
Cutoff: Medium-High	40.25

Document	Categorized Usage
Interview01	Medium
Interview02	Low
Interview03	Medium
Interview04	Low
Interview05	Medium
Interview06	Medium
Interview07	Medium
Interview08	High
Interview09	High
Interview10	Low
Interview11	High
Interview12	Medium
Interview13	High
Q01 (survey only)	Low
Q02 (survey only)	Low
Q03 (survey only)	High
Q06 (survey only)	High
Q07 (survey only)	Low
Q08 (survey only)	Medium
Q09 (survey only)	Low
Q11 (survey only)	Medium
Q14 (survey only)	High

Table 6: School socioeconomic status (SES) measure

(SES measure = percent of low income students from PA school report cards)

District & School (pseudonyms)	% low income
District A	60.7
Arrow	89.1
District B	82.2
Square	87.9
District C	31.4
Triangle	64.9
District D	6.5
Circle	6.0

Table 7: Potential factors affecting usage, literature source, and suggested influence

Key: "+" = factor influences usage
"–" = factor does not influence usage
'empty' = factor not mentioned

Factor	Schofield (1995)	Zhao et al. (2002)	Zhao & Frank (2003)
Experience using computers/technology	+	+	
Fit of technology with teaching practice and goals	+	+	+
Fit of technology with school culture and goals		+	+
Belief in value of/commitment to using technology	+		+
Benefit to using technology for teachers	+		+
Benefit to using technology for their students	+		-
Ease of using technology for teachers		+	+
Ease of using technology for students		+	
Ease of access to technology	+	+	
Presence of activities competing for teacher's attention	+		+
Presence of competing software			+
Peer influence on usage		+	+
Degree of peer support	+	+	+
Administration influence on usage		+	+
Administration support		+	+
Developer/Field support influence on usage			
Degree of developer/field support			
"Key person" influence on usage	+		+
Influence of technical problems on usage	+	+	
Location and degree of technical support	+	+	
Teacher training on ways to use technology in teaching practice	+	+	-
Feedback mechanisms between teachers and designers			

Table 8: Coding scheme used to code interview transcripts

(Report on nodes from N6)

QSR N6 Full version, revision 6.0.
PROJECT: Reading Tutor study N6 Copy - 08.02.04, User Peter Kant, 5:01 pm, Aug 12, 2004.
REPORT ON NODES FROM (1 2) '~/Teacher perception factors'
Depth: ALL
Restriction on coding data: NONE

(1 2) Teacher perception factors
(1 2 1) Teacher perception factors/Technical problems
(1 2 1 1) Teacher perception factors/Technical problems/Type
(1 2 1 1 1) Teacher perception factors/Technical problems/Type/Leveling
(1 2 1 1 1 1) Teacher perception factors/Technical problems/Type/Leveling/Computer selection
(1 2 1 1 1 2) Teacher perception factors/Technical problems/Type/Leveling/Student selection
(1 2 1 1 2) Teacher perception factors/Technical problems/Type/Repeat stories
(1 2 1 1 3) Teacher perception factors/Technical problems/Type/Headset
(1 2 1 1 4) Teacher perception factors/Technical problems/Type/Computer crash
(1 2 1 1 5) Teacher perception factors/Technical problems/Type/General
(1 2 1 1 6) Teacher perception factors/Technical problems/Type/Other
(1 2 1 2) Teacher perception factors/Technical problems/Way fixed
(1 2 1 2 1) Teacher perception factors/Technical problems/Way fixed/by Student
(1 2 1 2 2) Teacher perception factors/Technical problems/Way fixed/move to other computer
(1 2 1 2 3) Teacher perception factors/Technical problems/Way fixed/Teacher or tech assistant
(1 2 1 2 4) Teacher perception factors/Technical problems/Way fixed/Project LISTEN staff
(1 2 1 3) Teacher perception factors/Technical problems/Frustration with Tech problems
(1 2 2) Teacher perception factors/Benefits
(1 2 2 1) Teacher perception factors/Benefits/Student
(1 2 2 1 1) Teacher perception factors/Benefits/Student/Reading skill
(1 2 2 1 2) Teacher perception factors/Benefits/Student/Motivation
(1 2 2 1 3) Teacher perception factors/Benefits/Student/Computer skill
(1 2 2 1 4) Teacher perception factors/Benefits/Student/Reading practice
(1 2 2 1 5) Teacher perception factors/Benefits/Student/Content Knowledge
(1 2 2 1 6) Teacher perception factors/Benefits/Student/Motor skills
(1 2 2 1 7) Teacher perception factors/Benefits/Student/Anxiety reading
(1 2 2 1 8) Teacher perception factors/Benefits/Student/Speech skills
(1 2 2 1 9) Teacher perception factors/Benefits/Student/Indivudalized instruction
(1 2 2 1 10) Teacher perception factors/Benefits/Student/Other
(1 2 2 2) Teacher perception factors/Benefits/Teacher
(1 2 2 2 1) Teacher perception factors/Benefits/Teacher/Informal assessment
(1 2 2 2 2) Teacher perception factors/Benefits/Teacher/Easy to use
(1 2 2 2 3) Teacher perception factors/Benefits/Teacher/"I like it"
(1 2 2 2 4) Teacher perception factors/Benefits/Teacher/Other
(1 2 3) Teacher perception factors/Competing factors (Inhibitors)
(1 2 3 1) Teacher perception factors/Competing factors (Inhibitors)/Time
(1 2 3 2) Teacher perception factors/Competing factors (Inhibitors)/Other instructional practices
(1 2 3 3) Teacher perception factors/Competing factors (Inhibitors)/Available computing resources
(1 2 3 4) Teacher perception factors/Competing factors (Inhibitors)/Other
(1 2 4) Teacher perception factors/Data
(1 2 4 4) Teacher perception factors/Data/Do they use RT data? (How?)
(1 2 4 8) Teacher perception factors/Data/What data do they want? (Why?)
(1 2 5) Teacher perception factors/Teacher tool
(1 2 5 1) Teacher perception factors/Teacher tool/Use it?
(1 2 5 1 1) Teacher perception factors/Teacher tool/Use it?/Yes

(1 2 5 1 2) Teacher perception factors/Teacher tool/Use it?/No
(1 2 5 2) Teacher perception factors/Teacher tool/Know how to use it?
(1 2 5 2 1) Teacher perception factors/Teacher tool/Know how to use it?/Yes
(1 2 5 2 2) Teacher perception factors/Teacher tool/Know how to use it?/No
(1 2 6) Teacher perception factors/Monitoring
(1 2 6 1) Teacher perception factors/Monitoring/Yes
(1 2 6 2) Teacher perception factors/Monitoring/No
(1 2 7) Teacher perception factors/Scheduling
(1 2 7 1) Teacher perception factors/Scheduling/Consistency
(1 2 7 1 1) Teacher perception factors/Scheduling/Consistency/Consistent
(1 2 7 1 2) Teacher perception factors/Scheduling/Consistency/Inconsistent
(1 2 7 2) Teacher perception factors/Scheduling/Control over
(1 2 7 2 1) Teacher perception factors/Scheduling/Control over/Low
(1 2 7 2 2) Teacher perception factors/Scheduling/Control over/Medium
(1 2 7 2 3) Teacher perception factors/Scheduling/Control over/High
(1 2 7 3) Teacher perception factors/Scheduling/Other
(1 2 8) Teacher perception factors/How use
(1 2 8 1) Teacher perception factors/How use/Way
(1 2 8 1 1) Teacher perception factors/How use/Way/Individual students
(1 2 8 1 1 1) Teacher perception factors/How use/Way/Individual students/Selective
(1 2 8 1 1 2) Teacher perception factors/How use/Way/Individual students/Unselective
(1 2 8 1 2) Teacher perception factors/How use/Way/Flexible groups or centers
(1 2 8 1 3) Teacher perception factors/How use/Way/Whole class
(1 2 8 2) Teacher perception factors/How use/Purpose
(1 2 8 2 1) Teacher perception factors/How use/Purpose/Supplemental
(1 2 8 2 2) Teacher perception factors/How use/Purpose/Curricular
(1 2 8 2 3) Teacher perception factors/How use/Purpose/Remedial
(1 2 8 3) Teacher perception factors/How use/Other
(1 2 9) Teacher perception factors/View or Influence of others
(1 2 9 1) Teacher perception factors/View or Influence of others/Teacher
(1 2 9 2) Teacher perception factors/View or Influence of others/Specialist (Reading or technical)
(1 2 9 3) Teacher perception factors/View or Influence of others/Administration
(1 2 9 4) Teacher perception factors/View or Influence of others/Project LISTEN
(1 2 9 4 1) Teacher perception factors/View or Influence of others/Project LISTEN/J&K
(1 2 9 4 2) Teacher perception factors/View or Influence of others/Project LISTEN/Other PL Staff
(1 2 9 4 3) Teacher perception factors/View or Influence of others/Project LISTEN/Non-specific
(1 2 9 5) Teacher perception factors/View or Influence of others/Others
(1 2 10) Teacher perception factors/Teacher belief RT works
(1 2 10 1) Teacher perception factors/Teacher belief RT works/RT works
(1 2 10 2) Teacher perception factors/Teacher belief RT works/RT doesn't work
(1 2 10 3) Teacher perception factors/Teacher belief RT works/Doesn't know
(1 2 11) Teacher perception factors/Writing tool
(1 2 12) Teacher perception factors/Suggested improvements by teachers
(1 2 13) Teacher perception factors/Fit with curriculum

Table 9: List of interview questions

1. How did you first find out about the RT?
2. How did you learn how to use the RT?
3. How do you incorporate the RT in your teaching practice?
4. How does the RT affect your day-to-day work? (For example, does it make your work more complicated or less complicated? Or does it make it easier to manage your class or more difficult to manage your class?)
5. Are there specific factors that make it difficult for you to use the RT with your class?
6. Are there specific factors that make it easy for you to use the RT with your class?
7. What benefits does the RT offer to you?
8. What benefits does the RT offer to your students?
9. What kind of effect does the Reading Tutor have on your student's reading skill?
10. Can you think of things that could be done that would lead you to use the tutor with your class more frequently?
11. How does the RT fit with the curriculum?
12. How does the RT fit with the way things are done in your school?
13. How do other teachers in this school view the RT? (**follow up**) How does that influence the way you use the RT?
14. How does your principal view the RT? (**follow up**) How does that influence the way you use the RT?
15. How does Project LISTEN staff influence your use of the RT?
16. Is there someone in particular who has influenced your decision to use the Reading Tutor? (**follow up**) How so?
17. What do you do when you experience a technical problem with the RT? (**follow up**) How long does it take to get the problem resolved?
18. Do you use the Project LISTEN teacher tool? (If **yes**) How do you use it?
19. Is there any information that the RT or Project LISTEN could provide that would be helpful to you?
20. Is there anything which you would like me to clarify about the study, the interview questions, or do you have any final comments about what we've been talking about?

Table 10: Survey form distributed to teachers

Study of Project LISTEN's Reading Tutor

How much experience do you have using the Reading Tutor in your teaching practice?

1----------2----------3----------4----------5
None A moderate amount A great deal

How long have you been using the Reading Tutor? (For example: **2** years **3** months)

____ years ____ months

Excluding your use of the Reading Tutor, how much experience do you have using computers in your teaching practice?

1----------2----------3----------4----------5
None A moderate amount A great deal

How long have you been using computers in your teaching practice?

____ years ____ months

How much experience do you have using other kinds of technology (i.e. videos, slides, overheads, etc.) in your teaching practice?

1----------2----------3----------4----------5
None A moderate amount A great deal

How long have you been using these other kinds of technology in your teaching practice?

____ years ____ months

How easy is it for you to use the Reading Tutor in your teaching?

1----------2----------3----------4----------5
Not easy at all **Somewhat easy** **Very Easy**

How difficult is it for you to use the Reading Tutor in your teaching?

1----------2----------3----------4----------5
Not difficult at all **Somewhat difficult** **Very difficult**

How easy is it to get access to the Reading Tutor when you want to use it?

1----------2----------3----------4----------5
Not easy at all **Somewhat easy** **Very Easy**

How difficult is it to get access to the Reading Tutor when you want to use it?

1----------2----------3----------4----------5
Not difficult at all **Somewhat difficult** **Very difficult**

How important do you feel it is to use the Reading Tutor with your class?

1----------2----------3----------4----------5
Not important at all **Somewhat important** **Very important**

How supportive do you feel your colleagues are of you and your teaching practices?

1----------2----------3----------4----------5
Not supportive at all **Somewhat supportive** **Very supportive**

How supportive do you feel your principal is of you and your teaching practices?

1----------2----------3----------4----------5
Not supportive at all **Somewhat supportive** **Very supportive**

How supportive do you feel Project LISTEN is of you and your teaching practices?

1----------2----------3----------4----------5
Not supportive at all **Somewhat supportive** **Very supportive**

How frequently do you experience technical problems with the Reading Tutor?

1----------2----------3----------4----------5
Never **Somewhat frequently** **All the time**

In the past month, how many technical problems have you experienced relating to the Reading Tutor? (For example: **5** problems)

_____ problems

What is the most common kind of problem? (For example: **headset** or **computer crashes**)

_____

How quickly do problems get fixed?

1----------2----------3----------4----------5
Very slowly **Very quickly**

Typically, how long does it take to get a problem fixed? (For example: '**12** hours' or '**4** days' or '**2** weeks')

_____

Is there other reading software that you use with your students? (Circle) **Y** **N**

If yes, which programs? _____

_____

Do you prefer one program over another? (Circle) **Y** **N** Which program? _____

Why? _____

_____

If Project LISTEN provided you with a report showing the PSSA requirements that the Reading Tutor addressed, would that change the amount you used the Reading Tutor? (Circle) **Y** **N** If so, to what degree?

1----------2----------3----------4----------5

No change **Moderate increase** **Very large increase**

How old are you? **Age**: _____

Education (please check one):

____ Associate's (technical) degree
____ Bachelor's degree (B.S., B.A.)
____ some graduate school or continuing education credits
____ advanced professional degree (M.A.T., M.Ed., M.Sc.)
____ Doctoral degree (Ph.D., Ed.D.)

Ethnicity (please check as many as apply):

____ American Indian
____ Asian
____ Black (African American)
____ Hispanic
____ Pacific Islander
____ White (Caucasian)
____ Other (please specify _____)

Table 11: List of suggestions for improving Reading Tutor (by theme)

I. Curriculum integration

1. Segment stories by phonics (ex. short "a" stories, long "e" stories, etc.). Allow teacher to select which phonics skills student works on. Group and sequence stories following structure of basal readers.
2. Segment stories by subject matter to help teachers cover certain curriculum requirements (ex. George Washington: history; the solar system: science; etc.)
3. If do #2, consider aligning stories with national subject content standards
4. Add more comprehension exercises and assessments.

II. Data & data representation

1. Display student session progress and relate to overall student progress at end of session.
2. Centralize display of relevant reading measures – fluency (WPM), comprehension (% right), phonics (time-on-task per vowel), reading grade-level (2.3), etc. – possibly via Teacher Tool.
3. Provide printable reports for teachers for student assessment or parent conferences
4. Provide study pre-post test results of teachers' students
5. Use Teacher Tool as data and/or teacher communication clearinghouse. Provide information about the RT, its function, suggested uses. Consider a teacher discussion board to share tips and strengthen feedback lines.

III. RT interface

1. Improve graphics, visuals, and color to maintain children's attention & interest
2. Add menu function allowing teachers to select skills their students work on.
3. More positive reinforcement, affirmative comments. Add a cute "good-bye" to program.
4. Portfolio system to track records of kid and progress.
5. Improve design of Teacher Tool, not easily understandable by teachers

IV. Other

1. Allow stories to be printed directly from Writing Tool. Design 'edit' function helping teachers to correct student work and integrate RT into writing lessons.
2. Draw on reading research and instructional design experts from local universities to segment stories, improve interface and content of RT.
3. Consider future RT design in terms of teachers' use of RT as tool for review & reinforcement, practice, and supplemental instruction to traditional instruction.
4. Add more interesting stories and remove boring stories (ex. "Math" ones).
5. If possible, provide more computers to teachers.
6. Make accessible to teachers a list of all stories available in the RT.

BIBLIOGRAPHY

Bibliography

Cuban, L. (1986). Teachers and machines : the classroom use of technology since 1920. New York, Teachers College Press.

Cuban, L. (2001). Oversold and underused : computers in the classroom. Cambridge, Mass., Harvard University Press.

Cuban, L. (2001). Why are most teachers infrequent and restrained users of computers in their classrooms? Technology curriculum and professional development: adapting schools to meet needs of students with diabilities. J. C. Woodward, L. Thousand Oaks, CA, Corwin Press, Inc.**:** 121-137.

Dexter, S., Seashore, K.R. & Anderson, R.E. (2002). "Contributions of professional community to exemplary use of ICT." Journal of Computer Assisted Learning **18**(4): 489-497.

Dexter, S. L., Anderson, R.E., & Becker, H.J. (1999). "Teachers' views of computers as catalysts for changes in their teaching practice." Journal of Research on Computing in Education **31**(3): 221-39.

Dey, I. (1999). Grounding grounded theory : guidelines for qualitative inquiry. San Diego, Academic Press.

Pennsylvania Department of Education (2004). School and District Report Cards. Retrieved 03.15.04, http://www.paprofiles.org/pa0001/distlist.htm#Allegheny

Englert, C. S. & Zhao, Y. (2001). The construction of knowledge in a collaborative community: reflections on three projects. Technology curriculum and professional development: adapting schools to meet needs of students with diabilities. J. C. Woodward, L. Thousand Oaks, CA, Corwin Press, Inc.**:** 187-202.

Glaser, B. G. and A. L. Strauss (1967). The discovery of grounded theory; strategies for qualitative research. Chicago,, Aldine Pub. Co.

Granger, C. A., Morbey, M.L., Lotherington, H., Owston, R.D. & Wideman, H.H. (2002). "Factors contributing to teachers' successful implementation of IT." Journal of Computer Assisted Learning **18**(4): 480-488.

Gartner, Inc. (2002). Hype cycle of emerging technology. Retrieved 02.29.04, http://cis519.bus.umich.edu/GartnerHypeCycle.html

Holsti, O. (1969). Content analysis for the social sciences and humanities. Reading, Massachusetts, Addison-Wesley Publishing Company.

McLaughlin, M. W. (1993). What matters most in teachers workplace context? Teachers' work: individuals, colleagues, and contexts. J. W. M. Little, M.W. New York, Teachers College Press.

Mostow, J., & Beck, J. (to appear). When the Rubber Meets the Road: Lessons from the In-School Adventures of an Automated Reading Tutor that Listens. In B. Schneider (Ed.), Conceptualizing Scale-Up: Multidisciplinary Perspectives.

Mostow, J., Aist, G., Beck, J., Chalasani, R., Cuneo, A., Jia, P., & Kadaru, K. (2002). A La Recherche du Temps Perdu, or As Time Goes By: Where does the time go in a Reading Tutor that listens? Proceedings of the Sixth International Conference on Intelligent Tutoring Systems (ITS'2002), Biarritz, France.

Mostow, J., Aist, G., Burkhead, P., Corbett, A., Cuneo, A., Eitelman, S., Huang, C., Junker, B., Sklar, M. B., & Tobin, B. (2003). "Evaluation of an automated Reading Tutor that listens: Comparison to human tutoring and classroom instruction." Journal of Educational Computing Research **29**(1): 61-117.

Project LISTEN (2004). Description of Project LISTEN. Retrieved 03.01.2004, from http://www-2.cs.cmu.edu/~listen/

Schofield, J. W. (1994). Barriers to computer usage in secondary school. Social Issues in Computing: Putting Computing in Its Place. C. H. T. Finholt. New York, McGraw Hill, Inc.

Schofield, J. W. (1995). Computers and classroom culture. Cambridge ; New York, Cambridge University Press.

Schofield, J. W. (in press). Realizing the internet's educational potential. In J. Weiss (ed.), Handbook of Virtual Learning Environments. Kluwer Academic Publishers.

Smith, C. P. (2000). Content Analysis and Narrative Analysis. Handbook of research methods in social and personality psychology. H. T. J. Reis, C.M., Cambridge University Press**:** 313-338.

Strauss, A. L. (1987). Qualitative analysis for social scientists. New York, Cambridge University Press.

Strauss, A. L. and J. M. Corbin (1990). Basics of qualitative research : grounded theory procedures and techniques. Newbury Park, Calif., Sage Publications.

Taylor, S. J. and R. Bogdan (1998). Introduction to qualitative research methods : a guidebook and resource. New York, Wiley.

Tyre, M. J. O., W.J. (1994). "Windows of opportunity: temporal patterns of technological adaptation in organizations." Organization Science **5**(1): 98-118.

Waxman, H. C., Connell, M.L., & Gray, J. (2002). A quantitative synthesis of recent research on the effects of teaching and learning with technology student outcomes. Naperville, IL, North Central Regional Education Laboratory (NCREL).

Wong, K. P. L. (2004). "Reading tutor usage statistics." Personal correspondence. 02.14.2004 and 02.18.2004.

Yin, R. K. (1993). Applications of case study research. Newbury Park, Calif., SAGE Publications.

Zhao, Y. et al. (2002). "Conditions for classroom technology innovations." Teachers College Record **104**(3): 482-515.

Zhao, Y. & Frank, K. (2003). "Factors affecting technology uses in schools: an ecological perspective." American Education Research Journal **40**(4): 807-840.