Learning with Laptops: The Impact of One-to-One Computing on Student Attitudes and Classroom Perceptions

Chrystalla Mouza
University of Delaware, 132 E Willard Hall, Newark, DE 9716
Email: cmouza@udel.edu

Abstract: This study examined the ways in which two urban elementary school teachers integrated laptops in their instructional practices. It also investigated the impact of laptop integration on students' attitudes and perceptions of the classroom environment compared to control classrooms. Issues under student perceptions included: a) perceived importance of technology; b) computer enjoyment; c) student-teacher and student-student interactions; and d) motivation toward school and learning. The study used both quantitative and qualitative data. Although some evidence indicated that fourth grade laptop students had more positive attitudes toward school than fourth grade non-laptop students, quantitative data did not reveal significant differences among laptop and control students. Qualitative data, however, painted a positive picture of experiences in laptop classrooms. Laptop students perceived computers as important learning tools and consistently used educational applications to perform academic activities. Such activities influenced classroom interactions and created a sense of pride and empowerment among laptop students. These behaviors were not evident among control students.

Introduction and Purpose of the Study

Since the mid-1990s, schools have been implementing programs to bring portable technology into the classroom, primarily through the use of laptop computers. With Microsoft and Toshiba's Anytime Anywhere/Notebooks for Schools project, Apple's One-to-One, and IBM's Reinventing Education Project, extensive implementation of laptop program initiatives has become increasingly more popular. It was recently estimated that more than 1,000 schools are employing some type of laptop program and that at least one of every six school-districts in the U.S. has a laptop program in one or more schools (Windschitl & Sahl, 2002; Rockman, 2004). Many of these initiatives have been implemented at the individual school level and often selected classrooms, although recently programs have been expanded to include entire districts (e.g. Henrico County, VA) and even entire states (State of Maine). The most successful of these initiatives allow students to carry their laptops home, thereby offering the possibility of 24/7 access to technology.

With the rapid increase in the implementation of laptop programs, school boards and policy-makers are asking about their impact on teaching and student learning. Most of the research conducted so far is conceptualized as program evaluation and seeks to investigate the extent to which laptops are utilized in the classroom and their impact on student learning experiences (Rockman, 2004; Silvernail & Harris, 2003). Fewer studies seek to investigate changes in the learning environment or identify practices that utilize laptops within specific subject areas in ways that promote higher-order thinking (Windschitl & Sahl, 2002; Garthwait & Weller, 2005). The major outcomes of the studies conducted so far indicate that teachers use laptops for lesson development and instruction. Use of laptops for instruction, however, varies and does not always affect pedagogy. Several studies indicate that teachers often fail to take maximum advantage of the affordances of the new tools or move away from teacher-centered practices (e.g. Windschitl & Sahl, 2002). With regard to student learning, findings indicate that use of laptops can foster a) increased comfort level with computers, b) positive attitudes towards technology, c) increased motivation and engagement with school-work, d) frequent peer interactions, and e) increased self-efficacy. Cognitive outcomes are often inconclusive, though some reports indicate positive gains in student test-scores and problem-solving skills (Lowther, Ross, & Morrison, 2003; Muir, Knezek, & Christensen, 2004).

The study reported here was designed to provide further insights into the degree to which implementation of laptop computers can influence students' educational experiences. Specifically, the purpose of the study was to examine the ways in which two *urban, elementary* school teachers integrated laptops in their instructional practices and the impact of such integration on student attitudes and perceptions of the classroom environment. The two primary research questions were:

1. In what ways did teachers integrate laptops in their classrooms to achieve instructional goals?

2. How did constant access to laptop computers for instructional purposes influence students' attitudes and perceptions of the classroom environment compared to students in control classrooms? Under student perceptions the study considered the following issues: a) perceived importance of technology; b) computer enjoyment; c) student-teacher and student-student interactions; and d) motivation toward school and learning.

Context of the Study

The laptop program employed in this study was part of the Microsoft/Toshiba Anytime, Anywhere Learning program. Schools and parents in this program typically lease their notebooks from Toshiba resellers. Hardware and software are discounted, as are service and insurance contracts. The school described in this study was 1 of 52 other pilot schools located in an under-served area in New York City. At the time the study was conducted, the school was serving about 1,300 students in grades K-5. Almost all of the students were from low-income families who have recently moved to the U.S. from Spanish-speaking countries. A total of 3 classrooms participated in the school's pilot laptop program – 1 third grade, 1 fourth grade, and 1 fifth grade. The technology coordinator selected those classrooms based on two criteria: a) the classroom teacher participated in professional development on the use of technology, and b) the classroom teacher demonstrated an enthusiasm and prior evidence of integrating technology in the classroom. Participating students leased their notebooks and were required to pay $100 for insurance costs. Compared to other initiatives in which students received state of the art equipment (e.g. Maine initiative), students participating in this study received older, refurbished laptops that often varied in their capabilities and installed software. Further, laptops were not networked or connected to printers because the school lacked the appropriate infrastructure. Students had Internet access through two desktop computers located in their classroom. These are important considerations when trying to assess the impact and viability of laptop programs.

Methods

Participants

The study included 2 of the laptop classrooms – the third grade class and the fourth grade class. For each laptop class a comparable control class at the same grade level in the same school was also selected. Laptop and control classrooms were similar in the following two measures: a) they had students with similar characteristics – they were all monolingual classes in which students achieved at grade-level based on reading and mathematics test scores prior to the implementation of laptops; b) their teachers had previously participated in a year-long professional development program (2000-2001) on the use of technology offered by the Institute for Learning Technologies (ILT) at Columbia University.

Laptop and control classrooms, however, were different in two measures: a) access to technology – the control classrooms only had access to 2 desktop computers which was typical in the school; and b) teacher pedagogy and beliefs towards technology. The latter difference was unintended. The purpose of the study was to control for differential access to technology. Observation and interview data, however, revealed differences in control teachers' instructional practices and attitudes towards technology. Despite that, those were the only two classrooms that could serve as control classrooms. Other potential classrooms were bilingual or had a substantial number of students not meeting grade-level standards or the teachers had not participated in any technology professional development. Both laptop and control teachers had similar attitudes and beliefs towards technology when they entered the ILT program. Professional development, however, had different impact on teachers' practices and beliefs. After participation in professional development, for example, the two laptops teachers significantly altered their practices to incorporate technology (Mouza, 2002). This was the primary reason they received laptops in 2002 in the first place. The other teachers, however, made minimal efforts to alter their practices despite the acquisition of new technological knowledge and skills. Since laptop teachers received laptops because they "differed" in their pedagogical use of technology it would have been impossible to find control classrooms that merely varied in access to technology but not in other measures. Therefore, the study placed more emphasis on selecting classrooms with a comparable student population.

Data Collection and Analysis

The research design for the study was based on the collection of both quantitative and qualitative data from students and teachers associated with the laptop and control classrooms. Data were collected during the course of one academic year (2002-2003). The data set included classroom observations, teacher interviews, student surveys, and student focus groups. Each laptop classroom was observed on 6 different occasions. Control classrooms were observed twice. Observations focused on both pedagogy and laptop usage. Both laptop and non-laptop teachers

were interviewed once in May. Interviews elicited information on teacher practices and beliefs with regard to the use of technology in teaching and learning.

Quantitative data were collected through the Young Children's Computer Inventory (YCCI) questionnaire (Knezek, Christensen, Miyashita & Ropp, 2000). The YCCI is a 52-item Likert instrument for measuring elementary school children's attitudes on seven major indices: computer importance, computer enjoyment, motivation/persistence, study habits, empathy, creative tendencies (1), and attitudes toward school. The YCCI was implemented in multiple studies over a 10-year period (1991-2001). In all studies individual scale internal consistency reliabilities (Cronbach's Alpha) typically ranged from .66 to .85 for elementary/middle school students (Christensen, Knezek, & Overall, 2005). Data for this study were gathered using a 3-point rating scale: 1=Agree, 2=Sometimes, 3=Disagree.

A total of 100 laptop and control students completed the instrument during the months of April/May, 2003. To ensure the collection of usable surveys, all data were gathered in a small group setting. Each group consisted of 5 students. Each student was given a sheet listing only the response choices. The author and a research assistant read the survey items to the students and provided necessary explanations, thereby ensuring student understanding. The person not reading monitored students closely to make sure they were marking their answer to the appropriate location without skipping items. Each group of students took approximately 30-40 minutes to complete the survey.

The collection of qualitative data was based on 8 focus groups conducted with 32 students. Two groups of students from each class were selected to participate – one low-ability and one high-ability group. Focusing on both low and high ability students enabled the researcher to get a more accurate view of classroom reality whereby the perspectives of individuals with different abilities were captured. Low-ability and high-ability students were identified by their teacher based on classroom performance and personal judgment. Each group included 4 students. Focus group questions were targeted toward five major areas: a) computer importance; b) computer enjoyment; c) laptop usage at home; d) student-teacher and student-student interactions; and e) motivation towards school and learning. All focus groups were video-taped. Because there were no time constraints, the researcher ensured that the voices of all students' were heard. Examination of focus group transcripts reveals that almost all students responded in all focus group questions and multiple perspectives were generated.

Survey results were analyzed using statistical techniques (see Findings from Survey Data). All observation, interview, and focus group data were transcribed. Subsequently, they were analyzed using a grounded theory approach to look for commonalities and differences across student responses. The overall goal was to determine differences in student attitudes and perceptions of the classroom environment in laptop versus control classrooms. Three doctoral students who have not been part of conceptualizing the study or collecting the data were asked to independently code student responses. A consistent inter-rater coding was evident.

Findings

Technology Integration

Results from observations and interviews indicated that laptop teachers integrated technology habitually in their classrooms for a wide range of instructional tasks. Although the first few weeks of the year were difficult, laptop teachers gradually found solutions to common challenges. Some of the challenges faced included: a) re-arranging classroom furniture to allow for laptop access to electrical outlets; b) establishing routines for taking laptops out of backpacks and storing them away into locked cabinets; c) taking good care of the equipment; d) learning basic computer and file management skills; and e) figuring out ways for collecting student work electronically, since there was no access to a local area network.

After identifying strategies for addressing these challenges, students used their laptops extensively to accomplish a host of learning tasks. Besides word-processing software, students consistently used multimedia to report findings from research projects in social studies and science, to develop electronic storybooks in language arts, and to record sound from readings their own poetry. Concept mapping software, such as Inspiration, was also used extensively to brainstorm or organize ideas prior to the beginning of a writing task. Timeliner, was another software used extensively. Students routinely used Timeliner to prepare biographical or historical timelines related to topics studied in class. Further, students frequently used spreadsheets to graph and analyze data collected from classroom surveys or science experiments. Finally, students used desktop publishing software like Publisher to

prepare newsletters related to class topics. Contrary to laptop teachers, interview data revealed that control teachers made minimal use of technology in their classrooms. Students typically used computers for word-processing or conducting limited research using the Internet. In addition, computers were often used as a reward for students finishing their work.

Results from Surveys

Reliability analyses were performed to determine whether each of the seven subscales of YCCI were internally consistent and could be used in a MANOVA. Unfortunately, results revealed that only two of the subscales achieved alpha levels exceeding .70 (Creative Tendencies alpha = .71 and Attitudes toward School alpha = .75). In order to determine how technology in the classroom influenced Creative Tendencies and Attitudes toward School, a 2 (Technology in classroom) x 2 (Grade level) MANOVA was performed on the two reliable subscales. Creative Tendencies and School subscales were used as dependent variables. Box's Test of Equality was performed to test the null hypothesis that the observed covariance matrices of the dependent variables were equal across groups. Results indicated that the null hypothesis was retained (Box's M= 13.01, p= ns), suggesting that the covariance matrices for the groups were equal to one another.

Results from MANOVA suggested that technology alone or whether students were given a laptop did not influence their attitudes toward learning (Wilk's λ = .99, F (2, 95) = .37, p = ns). The significant overall multivariate effect for grade level, however, suggested that grade level alone influenced students' attitudes toward learning (Wilk's λ = .90, F (2, 95) = 5.27, p < .01, Partial η^2 = .100). Separate Univariate ANOVAs demonstrated that grade level had a significant influence on Creative Tendencies (F (1, 96) = 5.71, p < .05, Partial η^2 = .056) and Attitudes toward School (F (1, 96) = 8.86, p < .01, Partial η^2 = .085). When a Bonferroni adjustment was made to deter the inflation of Type I error, a more stringent, family-wise alpha level (.025) resulted. The adjusted results showed that third graders (M = 2.65) were significantly more likely than fourth graders (M = 2.51) to report having Creative Tendencies. Additionally, the corrected results reflected that third graders (M = 2.19) were significantly more likely to have positive Attitudes toward School than fourth graders (M = 1.85).

In order to determine whether the unique combination of technology in the classroom and grade level had an influence on student behavior and attitudes, results from the MANOVA were analyzed. Results yielded a marginally significant multivariate effect for the interaction (Wilk's λ = .94, F (2, 95) = 2.88, p = .06, Partial η^2 = .057). Although separate Univariate analyses revealed no significant interaction between technology and grade on Creative Tendencies (F (1, 96) = .283, p = ns), they did reveal the significant interaction between grade level and technology in the classroom on Attitudes toward School displayed in Figure 1 (F (1, 96) = 3.84, p = .05). After a Bonferroni adjustment was made to deter the inflation of Type I error, a more stringent alpha level (.025) prevented the interaction involving Attitudes toward School from being significant. Although this interaction was not significant, the means demonstrated that third graders who had laptops (M = 2.12) did not differ considerably from third graders who did not have laptops (M = 2.26) on Attitudes toward School, but fourth graders who did have laptops (M = 2.00) had more positive attitudes toward school than fourth graders who did not (M = 1.68).

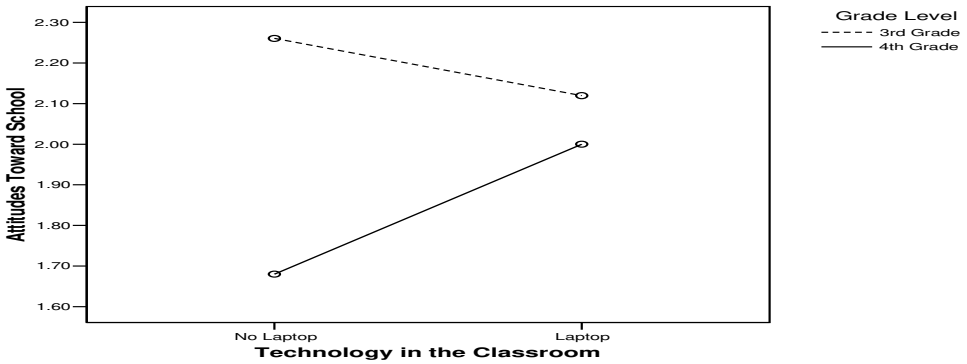

Figure 1: Students' Attitudes toward School

Results from Focus Groups

Computer importance. Findings from focus groups demonstrated that most students perceived computers as important tools for four primary reasons: a) they serve as an information resource; b) they are useful for future employment; c) they assist in the learning process; and d) they can be used to perform various tasks faster, easier and neater. Both control and laptop students viewed the computer as a tool that could provide information, particularly through the use of the Internet. They also commented on the importance of acquiring computer skills for future employment. A fourth grade laptop student explained: "In the future if you would like to become something in your life, you really need to know how to use the computer; you will need to have computer skills in order to do your job". Most students also reported that computers can facilitate learning by providing assistance with spelling and grammar, giving out correct answers (e.g. through the use of math games), providing access to information, facilitating the development of better looking and professional products, and allowing users to perform various tasks faster and easier. Students also appreciated the fact that they were learning new computer skills. The following excerpt from a group of third grade laptop students demonstrates their perceptions of the importance of computers in the learning process:

> S1: Laptops help you learn more.
> Researcher: How do they [laptops] help you learn more?
> S2. If you do not know how to spell a word you can find out using spell checker.
> S3. And when you forget to capitalize letters the computer does it by itself.
> S1. I also like the way you can explore and learn new stuff on the computer.
> Researcher: What kinds of new stuff can you learn on the computer?
> S1. Like different programs, Inspiration, PowerPoint and Word. When I have free time I like to check out stuff I have never looked up before and find out new things.

It is interesting to note that while control students emphasized the importance of computers as an information resource and for future employment, laptop students placed more emphasis on the advantages of using technology for learning. In fact, a group of fourth grade control students exhibited some ambivalence about the importance of computer in learning. One student noted:

> "I do not think computers can help you learn. That is what teachers are for. If you need any information you can go to the library or ask the teacher. I think computers are just for fun".

Another student agreed with the above comment and added: "Computers might tell you something or show you how to do something but they will not help you understand it. Only the teacher will do that".

Computer enjoyment. Results from focus groups also indicated that all students enjoyed working on the computer. Students reported an enthusiasm in using computers to play games, go to different websites using the Internet, or listen to music. Further, all students preferred word-processing on the computer rather than hand-writing documents. Laptop students, however, were also enthusiastic about using educational programs on their laptops, such as Inspiration, PowerPoint, and Timeliner. When students were asked to describe their favorite things on the computer the following conversation transpired among the high-ability fourth grade laptop students:

> S1: My favorite thing on the laptop is using Timeliner.
> Researcher: Why is Timeliner your favorite program?
> S1: Because you can create timelines with all the things you did in the past and the things you will do in the future. We did a timeline on ourselves about our past and future.
> S2: I like using laptops to create slideshows and multimedia presentations. You can use the Internet to download pictures and insert them in your presentation. It's really fun, because the slideshows pop out of nowhere.
> S3: And when you show it [slideshow] to someone they ask you: "How did you do that?"
> S4: I also like Publisher.
> S3: You can make news articles using Publisher. And there's Front Page, too.
> S4: That's where we develop websites with our articles.

When asked to report their least favorite thing about computers, students indicated that they are often slow to respond, they freeze and crash. Also, laptop students indicated that sometimes they experience difficulties with saving documents and need to repeat their work. Finally, some of the laptop students indicated that sometimes they are concerned about the safety of their laptop. They are concerned about having it stolen or accidentally damaging it and getting into trouble.

Student-teacher and student-student interactions: Student focus groups demonstrated that laptop students frequently traded skills with other students, shared technology related tips, and served as peer tutors for both technology and non-technology related topics. Such interactions were not evident in control students' responses. While laptop students, for example, reported assisting their peers and their teacher on a number of different instances, a third grade control student said:

> I have never taught my teacher anything. When we try to tell him something he does not really pay attention to us. When the whole class tries to tell him something he ignores us because he says that he is too smart and does not need any of our help.

In contrast, a fourth grade laptop teacher said:

> We often teach the teacher technical skills. She often asks us about various skills. If she doesn't know something she asks: "How did you do that"? Like the other time I highlighted and deleted a lot of items at once and she did not know how to do that and I taught her. I really thought she knew how to do it but she did not.

Trading with the teacher as well as their peers provided students with a sense of pride and empowerment. A fourth grade laptop student noted characteristically: "I feel proud when I teach the teacher something. The teacher is always teaching us, so now I feel, okay, "it is my turn to teach you"".

Motivation toward school and learning. Results from focus groups indicated that laptop students were very motivated to complete school work and homework using their laptops. Even though they reported enjoying playing games on their laptop, their responses did not reveal use of laptops for games at home. In fact, when asked what kinds of games they like playing on their laptops, most students provided examples of educational applications such as Inspiration or PowerPoint. Most students reported using educational programs at home to revisit and improve their homework, practice typing or learn new computers skills and figure out shortcuts. Control students in contrast, reported using home computers for games or to chat with others online. Overall, results indicated that laptop students were excited about doing school work on the computer and even initiated their own classroom projects that made use of technology. The fourth grade students, for example, suggested an activity to the teacher where they researched different topics of interest and presented their results in multimedia presentations at the end of each week by acting as reporters. Further, use of laptops provided a sense of empowerment. When asked about how does it feel to be a laptop student, a fourth grader said: "I feel really smart because laptop classes are for smart kids. It makes me feel like I am a genius or that I know more than others".

Discussion and Conclusion

Although quantitative data did not reveal significant differences in behavior between laptop and control students they provided important insights. First, it appeared that grade level made a difference in student responses. Third graders exhibited higher creative tendencies than fourth graders and more positive attitudes toward school. This finding might be due to differences in the third and fourth grade curricula. As students progress to higher grades, curriculum becomes more complex and teachers' expectations become higher. Further, fourth graders are under increased pressure because they are expected to take and perform well at the language arts and mathematics state tests. As a matter of fact, during the year that the study was conducted school administrators conducted several test preparation sessions with fourth graders. These events limited the amount of time that students could spend on solving problems in different ways and might have also influenced their overall attitude toward school due to testing anxiety or frustration with time spent on test preparation. Studies on academic intrinsic motivation, that includes creative tendencies such persistence, and the learning of challenging tasks, lend support to this finding. They indicate that academic intrinsic motivation in school declines over the years (Gottfried, Fleming, & Gottfried, 2001).

Quantitative data, however, indicated that fourth grade laptop students had more positive attitudes toward school than control students. This finding was evident in student qualitative responses as well. Students appeared to be enthusiastic about having laptops and reported enjoying school more because it allowed them to learn things in different ways. Third grade laptop students, however, did not appear to enjoy school more than control students. It is possible that the anxiety over learning new computer skills or damaging the equipment influenced student responses. Third grade laptop students did indicate that they initially felt nervous about having laptops because they did not have technical skills.

Overall, results from qualitative data painted a positive picture of experiences in laptop classrooms. Students not only perceived computers as important learning tools but also took advantage of the resources available

to them by consistently using educational applications to perform academic activities. These activities, in turn, influenced classroom interactions and created a sense of pride and empowerment among laptop students. These behaviors were not evident among control students.

This study investigated the implementation and impact of laptop computers on student perceptions of the classroom environment compared to students in control classrooms. The study focused on a limited number of classrooms in a single school. Neither teachers nor students were randomly selected which presents a limitation. Further, the lack of pre-post experimental data inhibits the study from establishing a strong cause and effect relationship between laptops and student perceptions. Despite these limitations, the study is unique in the following ways: 1) No other study has been conducted with students in lower elementary grades; 2) No other study has been conducted exclusively with inner city, minority students coming from low-income families. With the exception of the evaluation reports completed by Rockman that included a range of schools, the other studies were conducted in sub-urban, affluent schools; 3) The great majority of existing studies rely on survey data that are often supplemented by classroom observations or some anecdotal data. Rarely do studies include interview data that help illuminate student "thinking" on the issues under investigation. Results of the study are consistent with prior empirical studies but they help extend our understanding of the ways in which urban, elementary school students (in both laptop and non-laptop classrooms) think and talk about the role and importance of technology in school.

Endnotes

(1) Creative tendencies refer to students' inclinations to explore the unknown, take individual initiative or find unique solutions.

References

Christensen, R., Knezek, G., & Overall, T. (2005). Transition points for the gender gap in computer enjoyment. *Journal of Research on Technology in Education, 38*(1), 23-38.

Garthwait, A. & Weller, H. (2005). A year in the life: Two seventh grade teachers implement one-to-one computing. *Journal of Research on Technology in Education, 37*(4), 361-377.

Gottfried, A., Fleming, J.S., & Gottfried, A.W. (2001). Continuity of academic intrinsic motivation from childhood through late adolescence: A longitudinal study. *Journal of Educational Psychology, 93,* 3-13.

Knezek, G., Christensen, R., Miyashita, K., & Ropp, M. (2000). Instruments for assessing educator progress in technology integration. Denton, TX: Institute for the Integration of Technology into Teaching and Learning.

Lowther, D., Ross, S., & Morrison, G. (2003). When each one has one: The influences on teaching strategies and student achievement of using laptops in the classroom. *Educational Technology Research and Development, 51*(3), 23-44.

Mouza, C. (2002). Understanding teacher change: A study of professional development in technology integration. Unpublished Doctoral Dissertation, Teachers College, Columbia University.

Muir, M., Knezek, G., & Christensen, R. (2004). The Maine learning technology initiative: An exploratory study of the impact of ubiquitous technology on student achievement. *Research Brief MLLS0401*, Retrieved from, http://www.mcmel.org/MLLS/briefs/MLLS0401.pdf.

Rockman, S. (2004). Getting results with laptops. *Tech Learning*, Retrieved from http://www.techlearning.com/story/showArticle.jhtml?articleID=49901145

Silvernail, D.L. & Harris, W.J. (2003, March). *The Maine Learning Technology Initiative: Teacher, Student, and School Perspectives Mid-Year Evaluation Report.* Portland, ME: Maine Education Policy Research Institute. Retrieved from, http://www.usm.maine.edu/cpeare/mlti.htm.

Windschitl, M. & Sahl, K. (2002). Tracing Teachers' Use of Technology in a Laptop Computer School: The Interplay of Teacher Beliefs, Social Dynamics, and Institutional Culture. *American Educational Research Journal, 39* (1), 165-205.

Acknowledgements

The work reported here was partly supported by a postdoctoral fellowship from the Educational Testing Service (ETS) and a General University Research Grant from the University of Delaware. All opinions are the author's. I want to thank Carl Turner, Nancy O'Laughlin, Darlene Winnington, Rick Kralevich, and Michael Gutierrez for their assistance in the analysis of the data.