The Effects of High-Stakes Accountability on Ubiquitous Computing Initiatives: A Multiple-Case Study

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Introduction

Currently there is a concerted effort underway to understand the effects of technology on educational process and outcomes (Means, Haertel & Moses, 200; Means & Haertel, 2004). For the past decade there has been a commitment to building the infrastructure to provide schools with access to technological resources such as high speed computing devices (desktops, laptops, PDAs), the Internet, software and other digitally-based computing devices. In the last decade the student to computer ratio has dropped dramatically to somewhere between 9:1 to 4:1 (Norris & Soloway, 2004; NCES, 2001; Russell, Bebell & Higgans, 2004, Wenglingsky, 2005). Despite this diminishing ratio, technology has been slow to be implemented in classroom and effect changes in teaching and learning. Part of the problem has been with the models of implementation, with many computers being located in laboratories rather than in classrooms themselves. Increasingly, policymakers and researchers are asking what are the effects of technology on teaching, learning and student achievement?

Since the early 1990s there has been a movement to investigate the impact of computing technologies in which their application has become ubiquitous. What happens when all students in a classroom or school have access to a laptop computer or PDA device on a 24-hour, seven-days-a-week (24/7) basis? How does this change or enhance the processes of teaching and learning? There has been speculation that increased access to technology would lead to more use and greater impact on student learning.

Some researchers have concluded that ubiquitous computing is beneficial because of its positive influence on problem-based learning, ongoing assessment and communication among educational participants, more small group instruction, more

academic use of technology at home, and greater student engagement (Bebell, 2005; Van 'T Hooft & Swann, 2004). Other researchers have reported ubiquitous computing leads to an increase in time using technology, increased student motivation, increase in student writing time, increased individualization of learning and less whole-group, teacher centered instruction, and increased home use for academic work (Russell, Bebell & Higgans, 2004). One-to-one technology also leads to increased teacher and student use of technology, increases in student-teacher interactions and reports by teachers of improvements in student achievement and students' ability to retain content material (Bebell, 2005). However, researchers have also found that the structure of technology innovations including the "distribution of computer and Internet access in school buildings often limits the potential integration of technology-supported initiatives in schools" (Penuel, Tatar & Roschelle, 2004, p. 365).

Recently there have been calls for rigorous research and evaluation on the effectiveness of technology in general and on ubiquitous computing specifically (Means, Haertel, & Moses 2003; Means & Haertel, 2004; Van 'T Hooft & Swan, 2004; Zucker, 2004). Much of the existing research and evaluation of technology, and specifically ubiquitous technology, in education focuses on normative issues (see especially Penuel, Tatar & Roschelle, 2004) and technical issues such as implementation processes, the presence or absence of technical infrastructure, administrative support, pedagogical support, professional development, the uses of the technologies in classrooms, and assessment issues. While these are very important and necessary foci for research, the social and political contexts of implementation of technological innovations are often

ignored. These conditions have a significant influence on the normative and technical aspects of such innovations (Oakes et al, 1993; Shadish, Cook & Leviton, 1991).

Zucker (2004) draws attention to three components in a framework for investigating ubiquitous computing initiatives. Critical features of the 1:1 initiative, interactions and intermediate outcomes, and ultimate outcomes are related in a causal model. The critical features component includes such variables as the type of technology used, and the setting or level of implementation (school, district or state). Zucker specifies that "each setting has particular demographic, political and other characteristics (e.g., state curriculum standards and assessments)" (p. 373). Other critical features include the implementation plan and goals and objectives. Each of these critical factors can influence significantly intermediate outcomes, such as impacts on teaching and learning, school leaders, infrastructure and support, schools and systems, school-community relations, and costs and funding, which, in turn, influence the ultimate outcomes such as impacts on students and their learning, the digital divide, and economic competitiveness (p. 374).

This research study investigated how political and social contexts influence the implementation of ubiquitous computing initiative in schools. This paper presents the results of a cross case analysis of the impact of the social and political contexts, specifically, national and state accountability policy, on one-to-one initiatives from the perspective of the participants implementing the initiatives in four middle school sites. In another paper we address the relationship between accountability policies and specific and varying uses of ubiquitous technologies (See Dunleavy, Dexter, & Heinecke; 2006).

Social and policy contexts influence the definition of ubiquitous computing program goals and objectives, which in turn influence implementation plans.

Conceptual Context of the Study

Three strands of research literature frame this research on the intersection of educational policy and technology implementation. First, it draws on the literature about the social context of program evaluation. Second, it draws on the literature about accountability and high stakes testing. Third, it draws on the literature about changes in teaching and learning anchored in the National Research Council's report entitled *How People Learn* (Bransford, Cocking, & Brown, 2000).

Social Context of Program Evaluation

One of the critiques of evaluation research is that it often does not attend to issues of social programming. These issues can be broken down into three elements:

1. Internal program structure and functioning
2. External constraints that shape and constrain programs
3. How social change occurs, how programs change, and how program change contributes to social change (Shadish Cook & Leviton, 1991, p. 37).

Social programs and innovations operate within social, political and economic contexts. "Context plays an enormous role in the shaping programs, particularly during implementation… " (Shadish, Cook & Leviton, 1991, p. 38). Contextual pressures influence program administrators when thinking about how to implement programs with multiple goals and values. However, most evaluators attend more to internal issues than external influences on programs. The present study focused on the first two components listed above. It examines how external constraints shape and influence ubiquitous computing initiatives and how those factors may influence the internal structure and

functioning of ubiquitous computing initiatives. Two significant contextual factors influencing the implementation and use of educational technologies are national and state accountability policies and pedagogical approaches. Accountability and high stakes testing policies influence philosophies and practices of teaching and learning. Pedagogical approaches form the context for technology integration in education. A discussion of the impacts of accountability and high stakes testing policies on curriculum and instruction is important because pedagogical approaches are entwined with effective uses of technology (Wenglinsky, 2005).

Accountability and High-stakes Testing: Effects on Curriculum and Instruction

One of the most significant changes in the context of education to occur in the past 30 years has been the national movement to increase accountability. Beginning with Nation At Risk (National Commission on Excellence in Education, NCEE, 1983), and bolstered by the Governors' meeting in Charlottesville in 1991, the Goals 2000 Act, and the subsequent reauthorization of the No Child Left Behind Act, the push for improved content standards and accountability at the level of schools and pupil has reached it apex. Systems of accountability, including revised state content and performance standards, high stakes testing systems, accountability reporting systems and systems of rewards and punishment have been instituted by almost every state in the Union (Heinecke, Moon & Corcoran, 2003).

Researchers in the area of standards and accountability indicate that high stakes accountability systems have intended and unintended consequences for teaching and learning in classrooms. High stakes testing policies have been found to negatively impact the retention and graduation rates (Haney, 2000, Haney et al., 1999). Accountability

systems and high stakes testing influence the purpose of teaching, what is taught, and how teaching occurs (Pedulla, Abrams, Madaus, Russell, Ramos, & Miao, 2003; Popham, 2004). High stakes testing has been shown to have negative effects on curriculum and instruction. High stakes testing narrows the curriculum; often subjects that are not tested are not taught or are de-emphasized (Chudowsky & Behuniak, 1997; Firestone & Mayrowetz, 2000; Koretz et al., 1996; Jackson et al., 1999; Johnson & Johnson, 2002; McNeil, 2000, 2004; McNeil & Valenzuela, 2001; Shepard & Dougherty, 1991; Shepard, 2000; Smith & Rottenberg, 1991).

High stakes testing focuses instruction on basic skills (Resnick & Resnick, 1992). Classroom teachers operating under the pressure of high stakes testing policies are less likely to employ constructivist pedagogical methods (Harringon-Lueker, 2000), place greater emphasis on rote memorization (Gordon & Reese, 1997), decrease instruction in higher order thinking skills such as multi-task problem solving and sustained reading abilities (McNeil, 2004), increase drill and practice instruction especially by teachers in lower socio-economic schools (Barksdale-Ladd & Thomas, 2000; Darling-Hammond & Post, 2000), and decrease the self-autonomous tasks of students (Adams & Karabenick, 2000). Negative impacts of such systems include curricular reductionism, excessive test preparation and modeled dishonesty (Popham, 2004). Under conditions of high stakes testing, teaching tends to reflect the form of the tests given. State standards and accountability programs have resulted in the United States having a teaching force which primarily employs didactic approaches to teaching (Wenglinsky, 2005).

Wenglinsky (2005) asserts that there have been three major reform movements influencing the course of education in the past 20 years: the standards movement, the

technology movement and the movement to improve the quality of teachers. Wenglingsky describes the intersection of these three movements. He argues that the movements were vague in terms of definitions of classroom change and that they were not specific about the quality and types of changes in teaching required to improve student outcomes. He also asserts that these reform efforts were working at cross-purposes. Current federal accountability policy promotes didactic rather than constructivist approaches to teaching and learning at odds with calls for the teaching of 21st century skills and higher order thinking abilities. The vagaries and ambiguity of federal and state policies are usually worked out at the lower levels of the implementations system in school districts, schools and classrooms (Pressman and Widlavsky, 1973; Lipsky, 1980; Rein, 1976).

The Pedagogical Divide: Models of Teaching and Learning

In *How People Learn* (Bransford, Brown & Cocking, 2000) the National Research Council (NRC) proposed a radical shift in society's approach to teaching and learning. The National Research Council outlined the shift in conceptions of learning that have been occurring over the past decades due to developments in cognitive psychology. They argue that the "meaning of knowing has shifted from being able to remember and repeat information to being able to find and use it. …(R)ather the goal of education is better conceived as helping students develop the intellectual tools and learning strategies needed to acquire the knowledge that allows people to think productively about history, science, and technology, social phenomena, mathematics, and the arts"(p. 5). They acknowledge, however, that this approach is limited by curricula,

which emphasizes memory over understanding. They argue that useable knowledge is not the same as disconnected facts and emphasize conceptual and higher order understanding.

Based on their review of the research, the NRC (Bransford, Brown & Cocking, 2000) calls for school and classrooms which are learner-centered, knowledge- centered, assessment-centered and community-centered. This is challenging for schools because it calls for approaches to teaching and learning that are often times more difficult to do than simply memorizing facts. The NRC reports that many curricula are focused on disconnected facts and that standardized tests keep the focus on memorizing rather than understanding. According to the NRC, "…many standardized tests that are used for accountability overemphasize memory for isolated facts and procedures, yet teachers are often judged by how well their students do on such tests" (p. 141). Bransford et al. assert that state curricular standards vary in the models of learning promoted. They suggest that current forms of accountability testing may be detrimental to learning for understanding. The NRC acknowledges that current forms of accountability testing do not promote the teaching and learning for understanding called for in the report.

The way in which educators use technology in teaching, and consequently student use of computers in class, depends on administrators' and teachers' models of learning and philosophies of teaching (Bransford, Brown, & Cocking, 2000; Privateer, 1999; Wenglinsky, 2005). These models and frames of teaching and learning are often shaped by institutional dynamics. Privateer (1999) argues that current technology applications in education are framed by an efficiency model. He argues, "using technology to merely increase access to discrete bits of information or to improve performance on memory-

based tests forgoes applications of technology for the development of "metacritical thinking…" (p. 66).

Wenglinsky (2005) asserts that the effective use of technology depends specifically on whether a teacher uses a didactic or constructivist pedagogical approach. It is not the increase in access to technology which is important, so much as the quality of technology use that makes a difference for student achievement. In a national study examining the relationship between pedagogical approach and technology use based on NAEP test scores as the dependent variable, Wenglinsky found that students perform better in classrooms taught by teachers employing constructivist methods. Didactic teachers are prone to use technology for drill and practice, while constructivist teachers are more likely to use technology for real-world, problem solving. He concludes: " When technology is used in concert with constructivist teaching practices, students tend to perform well; and when it is used in concert with didactic practices, they do not" (p. 78). Other researchers have found that technology enhances a constructivist approach to pedagogy (Becker & Riel, 2000; Becker, Ravitz,& Wong 1999; Wenglinsky, 2005).

Other research studies have concluded that standards and accountability policies have a chilling effect on technology-enhanced teaching and learning. For instance, in a national survey study of writing teachers perceptions of the effects of high stakes testing on instructional uses of computers, Russell & Abrams (2004) found in a comparison of states with varying levels of stakes attached to state testing programs, that as the stakes increase, so did teachers responses about opting not to use computers for writing. They also found that rural and urban teachers in high stakes testing environments were less likely to use computers for writing. Current federal educational policy supports didactic

teaching approaches over constructivist approaches to teaching and are not likely to support the most effective uses of technology to address issues such as the achievement gap (Wenglingsky, 2005).

Many researchers have been critical of the role of technology in classroom innovation (Cuban, 2001). Often ignored in such critiques are the conditions surrounding implementation. Issues of social and political context are significant for investigations about the normative element of change in classroom practices (Oakes et. al., 1993, Shadish, Cook, & Leviton, 1991). We know that the way in which a technology is used depends on the pedagogical beliefs and approaches employed by administrators and teachers. We know that federal policies promoting basic skills through high-stakes accountability conflict with the constructivist approaches of technology use associated with improvements in student achievement (Wenglingsky, 2005). We do not know how these policies influence the implementation and use of ubiquitous computing initiatives specifically. Therefore, the following research questions were posed for this study.

Research Questions

What are the accountability policy contexts surrounding implementation of ubiquitous computing initiatives?

What is the relationship between accountability policies and ubiquitous computing initiatives from the perspective of implementers of the initiatives?

How do these accountability policies influence teaching and the integration of one-to-one technology into teaching?

It is clear from the literature that social context influences educational innovation. It is also clear that the context of accountability and high stakes testing are influencing the curricula and instructional approaches in ways which may be detrimental to teaching

and learning reforms advocated by the National Research Council. Didactic approaches do not maximize the potential for technology to contribute to effective learning. Specifically, these social and political variables may be having a deleterious effect on the ability of ubiquitous computing initiatives to promote educational improvements.

Methods of Study

Design

The study called for an investigation of how middle school teachers make sense of an innovation within a social context. Hence a qualitative multiple case study (Stake, 2006, Miles and Huberman, 1994) was employed to understand from the participant's perspectives how ubiquitous computing initiatives are implemented. Four middle schools sites were selected on the basis of the scope of their laptop programs. Each case exists within a range of cases of middle schools implementing one-to-one laptop initiatives. Four cases were selected because of limitations of resources and time and also to allow for interactivity between instantiations of the programs (Stake, 2006). Although the sites were not selected for statistical representation, they did allow investigation of 1:1 implementation within high stakes accountability contexts. Research team members collected interviews, observations, documents and artifacts as well as survey data from participants at each site. Individual case studies were completed for each site. Data was analyzed using methods of analytic induction (Erickson, 1986).

Site Selection

Data were collected about ubiquitous computing projects nationally. We identified a list of middle schools engaged in 1:1 computing initiatives. From that list we

selected projects that were being used in science and math courses. Four middle schools in two states, California and Virginia, were selected for inclusion into the study based on purposive sampling techniques. We originally chose two school districts in each state and planned on conducting our case studies on one school in each district. However, we failed to receive a complete data set from one site in California. In response we chose an additional middle school in one of the Virginia school districts and included it in our sample. This report is based on data collected from one middle school in California and three middle schools in Virginia. We chose the site in California based on familiarity with the site's initiative. We chose the remaining three sites because they were similar in size and scope of program implementation.

Accountability and Technology Policy: State Contexts

There have been several national and state-level conditions influencing the development and implementation of the ubiquitous computing initiative in Virginia and California schools (see Appendix 2 for further detail about the accountability and technology contexts of the two states). The No Child Left Behind legislation has increased the attention to standards, accountability, and testing. In both states the standards and accountability movement has led to the high stakes testing (Nichols, Glass, & Berliner, 2005). In addition, states have been developing policies regarding the use and funding of educational technologies. Both states included in the sample are states identified by researchers (Nichols, Glass, & Berliner, 2005; Russell and Abrams, 2004) as states with high stakes testing programs in which the stakes for schools and stakes for individual students are high, therefore, the accountability contexts for both states can be summarized as high stakes in nature. State policies in both Virginia and California are

also supportive of 1:1 computing initiatives although for different reasons. In Virginia, technology is viewed specifically as a means for facilitating goals related top passage of state accountability tests (e.g., online testing). In the following sections the contexts of the four research sites are described.

Description of Research Sites

Four middle schools (grades 6-8) in three school districts were selected as sites for data collection. The sites were selected through purposeful sampling. The selection criteria included presence of a mature implementation of 1:1 technology initiative, the nature of the initiative (laptops over PDAs), and, the willingness to participate and location. Cases were purposefully varied in terms of their geographic location. One site was a suburban site in a predominately rural area; the second suburban site was located near a major city. Two sites in a small urban setting were also selected for variation. Table 1 summarizes demographic information for each site. The sites were implementing various models of 1:1 computing. Table 2 summarizes the different characteristics of the ubiquitous computing initiatives studied.

Table 1
Demographic Information for School Sites (adapted from Dunleavy, Dexter, & Heinecke, 2006)

School	Level	Grades Served	Enrollment	District Type	Percentage Poverty[a]	Percentage Minority[b]
Fulton, VA	Middle	6-8	1,017	Suburban	47.15	24
Jackson , VA	Middle	6-8	551	Urban	21.9	54.7
Lewis ,CA	Middle	6-8	890	Suburban	62.3	76.3
Lincoln, VA	Middle	6-8	972	Urban	59.67	87.2

[a] Free and reduced lunch percentage
[b] African American, Hispanic, Asian, Pacific Islander, American Indian, Filipino

Table 2
Implementation Models and Fidelity to 1:1 (Adapted from Dunleavy, Dexter,& Heinecke, 2006)

School Name	Implementation Model	Ratio Achieved
Fulton, VA	Laptops Carts	Periodic 1:1
Lewis, CA	A combination of 1:1 Tablets and Thin client model	24/7 1:1 for tablets: 2:1 thin client
Lincoln, VA	Teams of 1:1 laptops classrooms within 6th, 7th, & 8th Grade	24/5 1:1
Jackson, VA	All 7th & 8th Grade students have laptops	24/7 1:1

Case study participants

Participants at each site were students, teachers (primarily in science and math), and central office and building-level administrators in four middle schools located in three school districts.

Data Collection Methods

A team of four researchers spent two days collecting data at each site. The data collected included individual interviews with 16 teachers, central office personnel, technology directors/media resource specialists from each school, principals from each school, focus group interviews with teachers, focus group interviews with students.

Interviews were guided by protocols derived from the conceptual framework and the guiding research questions.[1]

Twenty-seven teachers were observed teaching for approximately 1-2 hours. Observations were conducted using a protocol constructed from the research questions and conceptual framework of the study.[2] Observation field notes were written up in formal write-ups. In addition, a survey based on interview and observation data was constructed and administered to all teachers at each site. The survey consisted of 23 items including Likert-scale, multiple choice, and short answer.[3] All data were uploaded into NVIVO software by case for management and retrieval.

Within-Site Data Analysis

Using the qualitative analysis software NVIVO data analysis was constructed employing a coding scheme emic in nature as well as informed by categories salient to the conceptual framework. These categories included policy context, policy impact on teaching, goals and objectives, origin and history, and assessment practices. Descriptive statistics describing survey data were produced using SPSS and used as a form of triangulation. Once data was coded, the data record was read and re-read and constructed into a narrative case reports (See Dexter, Dunleavy, Heinecke, & Padina-Scott, 2005a,b,c,d[4]).

Cross-Site Data Analysis

The cases were then analyzed using techniques of Analytic Induction (Erickson, 1986) and Multiple Case Study Analysis (Stake, 2006, Miles & Huberman, 1994). Each

[1] See http://ubiq.edtechcases.info/overview/conceptual_framework.htm.
[2] See http://ubiq.edtechcases.info/overview/instruments.htm
[3] See http://ubiq.edtechcases.info/overview/instruments.htm
[4] See http://ubiq.edtechcases.info/cases/index.htm

case study was read and reread numerous times as analytic assertions were generated using the conceptual framework. A search for confirming and disconfirming evidence was conducted. A set of analytic assertions about key themes occurring across cases was constructed. A search for warranting data conducted. Assertions were refined and revised. Once completed, exemplars were selected and the report written. Below, the reader will find the assertions and narrative text explaining them along with exemplars from the data.

Findings

Assertion 1: Participants at each of the schools experienced pressure from the high stakes testing and accountability systems in their states and districts.

Assertion 2: High stakes testing/accountability policy influenced curriculum and instruction at the school sites.

Assertion 3: High stakes testing/accountability policy influenced the program definition and implementation of ubiquitous computing initiatives. Accountability-related purposes may be privileged due to external pressure associated with stakes of testing and accountability policy.

Assertion 4: Many participants perceived that the high stakes testing and accountability policy inhibited teachers' ability to implement 1:1 laptop initiatives.

Assertion 1: Participants at each of the schools experienced pressure from the high stakes testing and accountability systems in their states and districts.

While it is clear from the literature on educational reform that high stakes testing and accountability policies are having both intended and unintended consequences for teaching and learning, it is unclear how these contexts are experienced by teachers and how they influence reform and innovation initiatives. In the present study administrators

and teachers at the four case study sites indicated they felt they were under a significant amount of pressure from the accountability tests.

For instance, when describing the stakes associated with accountability environment of his district and school, the principal at Lewis Middle School said:

> Life or death is probably pretty close….it's our measure of our success as a school and a district. It's what's publicized in the paper. If we don't perform well on our state test, we are considered "a bad school." I mean, that's what they look at. And it's becoming more and more of a wave. And with the standards-based test, that becoming, and it's not necessarily that it's good or bad. It's that we have to make sure we're successful with that. It's one measure. Unfortunately, I think we make the mistake sometimes of chasing that test as opposed to looking at our own internal assessments and benchmarks and measuring how our own progress towards the standards, because you can get really trapped and say, 'Oh, that's the test and we need to do that' as opposed to really getting that feedback and dynamic in the classroom. (Principal, Lewis Middle School)

The principal at Fulton Middle School reiterated this point:

> …it is unrelenting, it really is, the pressure. …As an administrator you have to get the scores. There's no excuse not to. (Principal, Fulton Middle school)

As can be seen from Table 3 below, most of the teachers surveyed at the four schools perceived the state's accountability system to be high stakes in general and in their content areas. Thus it is safe to assume that the teachers and students at the four sites are operating under conditions of high stakes accountability pressure. The implications of high stakes testing policy for school curriculum and instruction are considered in the next section.

Table 3. Percentage of Teachers Reporting Nature of Stakes Associated with State's Accountability System in General and in Content Area as High Stakes.

	State System	Content Area

Fulton Middle School (n=32)	74.2	74.2
Lewis Middle School (n=29)	60.0	48.3
Lincoln Middle School (n=11)	54.5	54.5
Jackson Middle School (n=25)	80.0	76.0

Assertion 2: High stakes testing and accountability policies have negatively influenced curriculum and instruction

According to many participants the high stakes testing and accountability systems have negatively influenced curriculum and instruction at the school sites. For instance, in Harvey City where Jackson Middle School is located, the accountability press is viewed as being high. The Division has aligned its curriculum to the State's accountability tests (Standards of Learning-SOL) . The formation of Jackson Middle School coincided with the implementation of the State's accountability plan. It influenced the plans to turn Jackson into a magnet school with block scheduling focused on math and language arts and quarterly assessments matched with the SOL tests. It also influenced the decision to create the middle school along departmental model rather than the teaming model associated with the middle school movement. According to the Principal at Jackson Middle school:

> When we made that leap… in our seventh year that we weren't going to have teams when we opened this school, I took a deep breath. I thought I was doing something immoral or at least illegal. You know because middle school concept was …middle school teams. …But we discussed it, the teachers that had been hired, and said …we were SOL-driven at that moment, 'What way can we address the SOLs best?' And they said, 'We need to be departmentalized.'…We are SOL

> driven, but… more No Child Left Behind-driven at this moment. (Principal, Jackson Middle School)

The Assistant Superintendent of Secondary Instruction stated:

> With the SOLs? It has influenced instruction, because we have gone back and aligned all of our curriculum to the SOLs. We've done a pacing guide so that we know that everything is being covered, and when it is being covered. It has influenced how resources are directed. It really has influenced, basically, everything that we did…. We've realigned resources; we've changed how we work; we've changed even our structure here in the central office. (Assistant Superintendent, Harvey School Division)

She admitted that the impact of the State's standards and testing policy has not been entirely positive:

> Knowing that the SOLs were going to be so important to the children and to the schools, we put our resources primarily in the academic core areas. And so it was a matter of just using the human resources a different way. And because we were a new school, we could say, "We just don't offer French." And no one is zoned to come here. They choose to come here. So if I want French, I'll go to this other school. So be it. (Assistant Superintendent, Harvey School Division)

The Harvey City School District instituted a technology-based assessment system in which benchmark tests are administered, scored and results shared for instructional use. The accountability pressure has changed the curriculum and instructional approach of the school division. A math teacher at Lincoln Middle School explained:

> The Standards of Learning are minimum competencies that students are expected to achieve. And the hardest thing for me to get across as an instructional leader to my teachers in mathematics is that that's just the basics….that I expect them to take kids a whole lot further than that. But they're so concerned with those SOL tests that they stick directly to them. And unfortunately they don't add richness to their math classes. And I see students just losing out on so much in things that they could learn in relation to mathematics. …But I think that what we've done also is cut away from some of the creativity in classrooms of teachers that are not as confident as maybe I am. Because sometimes… a lot of times, I take my kids on journeys that are kind of related to SOLs, but I think it's important for the next step. A lot of times teachers don't look to see where the kids came from and where they're going in terms of their math knowledge to try to bridge that gap

> either. They just look at the curriculum, teach SOLs, and that's it. So, to me that's an area that I'm concerned about. (Math teacher, Lincoln Middle School)

The principal at Fulton Middle School commented how the accountability press negatively influenced curriculum and instruction:

> …the creativity in expanding a topic beyond what you need to get it covered. A real good example, one of the SOLs in sciences involves genetics, well yeah, you teach them how to do the Punnett squares, you do a couple of basics, …and you move on and you spend maybe a day on it. I mean, there's so much you could do with that. You have your little fruit flies growing in the little medium and you could be, I mean, you could spend a month on that kind of stuff and the kids would have a much greater deeper sense of genetics and all the kinds of… and a whole controversy on genetic engineering and cloning, and again that more global knowledge, but you can't do that because you've got to get genetics and Punnett squares done today because tomorrow you've got to move on to parts of the cell and it's time to go, you don't have a chance to go back and do that. Really cool programs on the computer too where you can do crosses and stuff, it's great, but you don't have time for it because you've got to go on the next. (Principal, Fulton Middle School)

There are certainly indications across the cases that the high stakes nature of the accountability and testing policy has had an impact in the curriculum. School division, schools and teachers have responded to these mandates in the cases we examined. One of the results is that the curriculum looks more like the tests themselves, and there is less time for deep investigations of topics. Table 4 indicates that teachers at our sites felt they were under a great deal of pressure to teach to the States' high stakes tests and that those tests influence their teaching a great deal.

Table 4. Percentage of teachers reporting pressure to teach to High Stakes Testing (HST) and extent to which High Stakes Testing influences teaching as "High"

	Great Deal of Pressure to teach to High Stakes Tests	High Stakes Tests influences teaching Great Deal

Fulton Middle School (n=32)	62.5	84.4
Lewis Middle School (n=29)	51.7	51.7
Lincoln Middle School (n=11)	81.8	81.8
Jackson Middle School (n=25)	76.0	80.0

It is clear from this assertion that, according to the participants in the study, the high stakes testing and accountability policies have had a significant effect on curriculum and instruction at the sites studies. The effect has been to narrow the curriculum and reduce the amount of time available for exploration of topics. How the high stakes testing policies have influenced the ubiquitous initiatives is where we turn next.

Assertion 3: High stakes testing and accountability policies influenced the definition of the ubiquitous computing programs. Among many defined objectives for the one-to-one program, assistance with assessment for accountability purposes was a frequently cited objective.

All educational programs, reforms and innovations have goals and objectives that influence their definition and implementation. As with any program there were multiple perceptions about the purpose of the ubiquitous computing initiatives held by various program participants at the sites. Using technology to improve equity, excellence, choice, and efficiency or accountability were among the purposes for the laptops cited by study participants. Preparing students with technology skills for workforce development, preparing students for state and local accountability tests, increasing modalities of learning, and increasing equity of access to educational resources, were among the purposes held by some stakeholders for the use of the laptops. Certain of these purposes

may be privileged due to external pressure associated with stakes of testing and accountability policy.

In Harvey City School District in which Lincoln and Jackson Middle Schools are located, The State's accountability policy influenced the selection of sites for the laptop program. When the laptop program was initiated, the State had an assessment for 8th grade technology skills (that has since been dropped). But at the time, school district leaders acknowledged that testing pressure did influence their choice of seventh grade as the target grade for the laptop initiative. In the case of Fulton Middle School, the accountability policy has influenced the rationale and definition of the laptop program. The Superintendent stated:

> So the Standards and Accountably movement actually gave me the big stick I needed… so I used the old 8th grade SOL technology objectives like, well, we've got to have this in order to teach this and then when those kind of wore out, I used the old, well, we're going to be doing all these tests online, the state says that these SOL tests are going to be all done by computer. Okay, and if you're doing it and they're going to test, if they think it's important enough to test, then by golly, that's what we're going to do and it's going to get measured and they're going to see that we're doing it. (Superintendent, Hickman County Schools)

At Jackson Middle School the laptop initiative is seen as a vehicle for attaining SOL goals and for moving beyond them. The Assistant Superintendent of Secondary Instruction describes the accountability press in the division as "Huge."

At the Division level, the objectives and goals of the laptop initiative at Fulton Middle School were defined by the SOL tests. According to a 2004 evaluation report[5] the criteria for success are "geared…to instruction and the SOL testing." The operational objective "grew out of the Virginia Standards of Learning for Technology" and the criteria for success were the students "using these laptops in order to achieve these eighth

[5] This report has been redacted to ensure confidentiality.

grade competencies." The Hickman County School Division's technology coordinator commented how the state's accountability initiative was used as a rationale for the laptop initiative: "once you gear the laptops to testing then the parents are going, oh, that's what we can use them for" (Hickman County Division Technology Coordinator). The Division leadership also encourages the use of the lap tops for SOL preparation: " We use it for some in-house testing also. …There are some web sites…some teachers have gotten very industrious in this state, there's a web site where you can actually do practice testing" (Superintendent, Hickman County Schools). The Division's Technology Coordinator echoed the superintendent: "And there's a site called Learnstar that …we're putting into the middle schools that actually have tests for every curriculum-based area and also the teacher can create their own tests and put them on line" (Hickman County Schools Director of Technology).

When considering the expansion of the technology program the Superintendent always ties it to improvements in test scores: "… I say, how is this going to improve our test scores" (Superintendent , Hickman County Schools). To a certain extent, there are more diverse criteria for success at the classroom level that include instructional differentiation, lesson reinforcement, individualized instruction, and student motivation. At the classroom level, the goals of using the laptops are SOL-driven while incorporating pedagogical and behavioral components as well. For example, a math teacher explained the individualized instruction and reinforcement opportunities provided by the laptop use:

> Basically, is to, of course, have higher SOL scores and I think my students accessing the laptops, especially students who do not catch it the first time as far as instruction, you know, direct instruction in the classroom, when they utilize the laptops then it definitely helps them because it's more of a one on one situation. (Math teacher, Fulton Middle School)

Commenting on the purpose for integrating technology into the curriculum within the context of high stakes accountability policy, the principal at Lewis Middle School in California stated:

> The reality is that,…all of the other stuff that we do, if it looks cool and it's exciting and innovative, if we're not seeing results, what's going to happen is, and whether you're a governing board member or a community member, if we're not seeing something in those results, because that is the measure that the state looks at. We've got to show some results there even though we may have some other measures that tell us that we're doing well. If we don't do well in those measures, it's kind of tough to sell the others. (Principal, Lewis Middle School)

The Principal also stated that the high stakes testing pressure does influence the way in which use of technology for assessment is conceived:

> Now part of that has to do too with making sure that we do assess in a format that's similar to the standardized testing because that, as you well know, sometimes that's where it falls apart. Kids have demonstrated mastery and assessment that is not similar to the way it's assessed on a standardized format and, consequently, are not able to demonstrate that mastery in a standardized format. (Principal, Lewis Middle School)

In summary, while there were diverse goals for laptop projects cited by many of the participants in the study, improvement of student achievement, sometimes specified as results on state accountability assessments, was ephasized influencing program definition. While there were many uses of the laptop across the cases, drill and practice and assessment were two of the primary uses of the laptops across sites (See Dunleavy, Dexter, & Heinecke, 2006; Dunleavy, 2006). In these cases, high stakes testing policies influenced the definition of the purpose of the laptop innovations as well as a focus on the use of the laptops for assessment.

*Ass*ertion 4: High stakes testing and accountability policies influenced and inhibited teachers' ability to implement 1:1 laptop initiatives.

Across the cases it was clear that participants felt that the high stakes accountability policies constrained their ability to integrate the technology into their instruction. This occurred because high stakes testing focused instruction on the facts and skills contained on the tests, limited the time available for exploration and planning with the laptops, and limited effective technology-enhanced instruction. It also occurred as the testing pressure inhibited constructivist or creative approaches to teaching with technology. A teacher at Jackson Middle School exemplified this when asked how his technology use would be affected without the SOL testing pressure:

> I would probably use them (laptops) a lot more as far as for a research base, because there would be more time to do research and projects in the classroom. For instance, we get to do that career project, but I would probably like to do more. We used to do a greenhouse effect lab in Algebra I. We don't have time to do those anymore…. because of the SOLs. Because everything we do in this classroom, now, we have been told if a visitor walks through, and we cannot somehow show that it relates to the SOLs, don't do it. And that is a very real. That is exactly what we have been told. (Teacher, Jackson Middle School)

Another teacher at Jackson who indicated how technology creates potential for depth in teaching related how the accountability policy has restricted her use of technology but at the same time technology has the potential to move beyond the basic skills emphasis of the tests:

> Absolutely. It (high stakes test) has seriously restricted my teaching with the computers. The pressure of the standards has to be the first thing that I worry about. For example, I am a literature person. That state assessment doesn't care if the students have never read Frost or Hemingway or Pope. They just care that they can identify imagery. If they can identify imagery in Dr. Seuss, it seems to me the state is happy, as long as they can identify imagery. So, for me, I have felt the pressure of getting the kids prepared for an assessment, regardless of the literature. I have almost been told in department meetings downtown, don't worry about the stories, and teach the skills. But I want to be more than a skills

> teacher. I also want to be a literature teacher. The standards have restricted me. I don't think the use of the technology has. (Teacher, Jackson Middle School)

A math teacher at Lincoln stated the accountability tests have restricted use of technology:

> I think for some teachers it's probably added some more pressure because they say, "Here I have this curriculum that I'm supposed to cover in X number of days and now you're asking me to take this machine and use it also to try and get these standards covered. (Math Teacher, Lincoln Middle School)

The principal at Fulton concurred that the testing press inhibits the effective use of the lap top technology: "I think it hinders the use of technology because …it doesn't allow the teachers to be as creative with their lessons perhaps as they would like to be because they simply do not have the time to go that extra mile on a certain subject, they've got to cover the material. So I think in a lot of ways it [accountability program] hinders it … ." The principal at Lewis Middle School in California commented about the relationship between the high stakes accountability policy and the effort to integrate technology into instruction:

> I'll be honest with you we have so many things on our plate right now, to try to orchestrate that has been a nightmare. And the teachers are just feeling overwhelmed. With all that they're doing right now, in the standards-based environment, looking at the technology, pushing the envelope with the technology… . (Principal, Lewis Middle School)

A teacher at Lewis commented on the impact of the accountability policy on the technology initiative:

> Its effect on the technology initiative, though-- …implementing technology, and then of course, a real strong testing, accountability push came in California. There are so many important and wonderful things about accountability to the standards, but one of the things that I feel does happen if you don't feel confident that you are a teacher who is being effective, it is harder to throw yourself into learning to apply and use the technology when you are really nervous about … accountability that is focused on this test score. Especially when there has been no assurance that if you throw yourself into this, your test scores are going to

> zoom up. … But at any rate, that's an effect that I think it has had on technology. It can create a greater tension about technology, because I have to abandon what I know as a teacher and now start using this. Maybe I am going to screw up these kids, or my test scores are going to go down. …For instance, if you are the teacher, right now, in our district, and you are working with English language development students, and our scores have gone down, you did not have enough time in the day to do other things. It is pretty hard for you to say I'm going to devote more time to this, when my butt's on the line, or the district's. There is tension for that. So I think for some teachers that would be an inhibitor. (Teacher, Lewis Middle School)

The following tables (tables 5-7) reporting survey results at the school sites, indicate that these comments were indicative of the experiences of teachers at the schools. About a half to two-thirds of the teachers at these schools feel that the high stakes tests hinders their ability to integrate technology into instruction a great deal or somewhat (see Table 5). About a third to two-thirds of the teachers responding felt that high stakes testing restricts time available for integrating technology (see Table 6). And finally, not very many teachers, except at Fulton Middle School, feel that the high stakes testing policy encouraged them to use technology in a wide variety of ways (see Table 7).

Table 5. Percentage of Teachers Reporting High Stakes Testing "hinders a great deal" or "somewhat" their ability to integrate technology in instruction

	Hinders a "great deal" or "hinders somewhat"
Fulton Middle School (n=32)	48.4
Lewis Middle School (n=29)	41.4
Lincoln Middle School (n=11)	63.6
Jackson Middle School (n=25)	63.6

Table 6. Percentage of Teachers Reporting HST hinders Time Available for Technology Use

	"Strongly Agree" and "Agree" High Stakes

	Testing "restricts time for technology use"
Fulton Middle School (n=32)	48.4
Lewis Middle School (n=29)	31.0
Lincoln Middle School (n=11)	63.7
Jackson Middle School (n=25)	63.7

Table 7. Percentage of Teachers Reporting HST Encourages Use of Technology in Wide Variety of Ways

	"Strongly Agree" and "Agree" that High Stakes Testing encourage use of technology in wide variety of ways
Fulton Middle School (n=32)	45.2
Lewis Middle School (n=29)	17.2
Lincoln Middle School (n=11)	27.3
Jackson Middle School (n=25)	27.3

It is clear across the sites studied participants indicate that the high stakes accountability policies negatively influence their ability to creatively integrate one-to-one technology into instruction. Administrators and teachers are focused on teaching basic skills for the test preparation. According to many study participants, just as high stakes testing narrows the curriculum, it can also narrow the way in which laptops are used in teaching and learning. The emphasis on accountability restricts time for constructivist uses of technology. Teachers feel torn between spending their time preparing students for mastery of basic skills for test preparation and using the technology for more creative and higher order learning activities.

Summary

There are a variety of conditional factors that influence the effective implementation and use of one-to-one laptop computing in teaching and learning. Appendix 1 summarizes the findings across the cases in this study. In each of the sites studied, it was clear that participants felt the pressure of high stakes testing and accountability policies. It was also clear that participants felt the accountability policies impinged on their instruction. The accountability tests kept teachers focused on a large amount of content that had to be covered. The accountability press restricted the amount of time teachers had to explore topics with technology. In addition, participants indicated that the high stakes testing policies are one factor among many constraining laptop use. Other conditions included program definition and organization, technical conditions, leadership, technical and instructional support, and individual teacher investment and use.

At none of the sites was there a school-wide instructional reform effort aimed at encouraging real-world problem solving or student-centered instructional approaches, two conditions cited as conditional variables which tend to maximize the effectiveness of ubiquitous computing (Wenglingsky, 2005). While it cannot be said that the context of accountability policies drove or limited the types of instructional uses, we can conclude from the cases that such policies created a context teachers believe limits rather than facilitates the use of technology for higher order and conceptual learning. There were indeed pockets of such use, but no coordinated or school-wide applications of such use.

Discussion

In *Technology and Assessment, A Tale of two Interpretations*, Russell reminds us that while it may be important to use technology for the development of basic skills in order to perform well on standardized tests, it is likely that such uses come at the expense

of using the laptops to develop "higher order research, reasoning, and communication skills" (Russell, 2006, p. 208). It may be that accountability and high stakes testing policy contradict the basic requirements of the new learning environments and the use of technology in those environments (Bransford, Brown, & Cocking, 2000). Such policies may not facilitate a learner-centered environment. The high stakes and associated pressure may restrict the time necessary to create a truly knowledge-centered environment. Such policies keep the curricula focused on memorization of disconnected facts emphasizing memorization over understanding. They may interfere with the time necessary for the teaching of metacogntive strategies. High stakes testing environments also impinge on the assessment-centered requirements of the new learning environments. They do not provide students with opportunities to revise and improve thinking or to help students see their own progress over time, or help teachers identify problems to be remedied. Lastly, the competition and rank ordering, which often accompany high-stakes standardized testing regimes, do not promote a community-centered approach to learning. They do not promote intellectual camaraderie and the building of a sense of community.

In addition, high stakes testing and accountability policies may constrict the ability of teachers to leverage technology for more learner-centered and constructivist approaches to teaching and learning (Wenglinsky, 2005). Evidence from this study suggests that this dynamic may be occurring, though examination of the effect of conditional variables on specific uses of laptops requires further examination. Grogan & Roland (2003) in their study of 11 exemplary teachers responding to the accountability mandate in Virginia, found that "good teachers" went beyond the basics of drill and practice to raise test scores. We may be witnessing a similar phenomenon with laptop

teaching in that the "good" or experienced teachers may be able to rise above accountability pressures to use the laptops in innovative ways. However, the bulk of teachers maybe influenced by the high stakes tests, restricting the potential uses of laptops in effective instruction.

This study also raises implications for evaluators of ubiquitous computing initiatives. It is imperative that such evaluators consider the social and political context surrounding the implementation of these initiatives (Shadish, Cook, & Leviton, 1991). These conditional variables influence the definition of purpose and criteria for success of one-to-one computing initiatives. Initial frames and definitions have lasting impacts on program definition and program delivery. Finally, we are reminded by this study that technology is not neutral nor does it enter into a neutral educational context.. "Technology can serve as a more efficient delivery system for weapons of mass instruction, or it can serve as a catalyst for re-engineering education in pursuit of learner-centered, knowledge-centered, assessment-centered, and community-centered educational environments" (Heinecke, 2006, p. xi).

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Appendix 1

Table 8	Lewis	Fulton	Jackson	Lincoln
School Characteristics	Regular; suburban public	Regular, rural public	6-8 Math/LA gifted magnet School; suburban public	Regular, suburban public
State Technology Policy Context	Commitment to ubiquitous computing, equity of access inhibited by funding constraints,	Support for 1:1 to support online testing	Commitment to technology funding, laptop initiatives, on-line accountability testing,	Commitment to technology funding, laptop initiatives, on-line accountability testing,
State Accountability Test Demand	Moderate-to high stakes and test demand	High, Virginia SOLs, NCLB, High stakes testing at grades 3, 5,8,12; Graduation denial; publicized comparisons	High, Virginia SOLs, NCLB, High stakes testing at grades 3, 5,8,12; Graduation denial; publicized comparisons	High, Virginia SOLs, NCLB, High stakes testing at grades 3, 5,8,12; Graduation denial; publicized comparisons
State Accountability Status	Accredited	Accredited	Accredited	Accredited
Laptop Program Purpose (stakeholders)	Enhance equity via improved access, expand learning modalities for student engagement; improve student achievement,; enhance technology skills for employment; Link class rooms to homes-improve student-teacher-parent relationships;	Technology skills for workforce preparation Increasing accountability test scores	Enhance curriculum and instruction beyond state standards, increase student performance and meta-cognitive abilities, increase equity of access, variation in learning modalities, higher order thinking outcomes; community press for employment preparation But…Technology assisted assessment tied to SOLs; Program not related to other curricular reform efforts	Enhance curriculum; increase student academic performance; Increase equitable access; workplace preparation; impact on advanced courses; increase student engagement

Table 8	Lewis	Fulton	Jackson	Lincoln
Program Initiation and Implementation	Top-down; Asst. Supt vision and initiative	Top-down; County administrator and Supt. Of Schools	Top-down; Superintendent vision, Division-level, city support, limited local funding; restricted program scope);Not school-wide	Top-down; superintendent vision; division-level, city support;
Program Design	2:1 throughout school; 1:1 partial, sub-groups of 6-8th graders with 24/7 access.	From 24/7 to 4th and 8th to laptop carts	Grades 7 & 8 24/7 access I-Books w/OS 10.3.4, MS Office, Inet, 128 MB HD, textbook software; school-wide wireless; no school-provided email capability;	Grades 6,7 & 8 ; 300 students and 12 teachers One laptop team per grade 24/5 access I-books with OS 10.2.8; MS Office, I-Net Explorer; Textbook software 276 desktops in 5 labs 164 laptops on 11 carts Wireless network
Perception of Test Demand at School	Most teachers perceive as high	High	High	High
Influence of Test Demand on Organization and implementation of Instruction	Significant influence	Significant	Significant influence; Division curricular alignment;	Significant
Influence of Test Demand on Technology Integration	Negative; Hinders teacher integration	Negative; Hinders teacher integration	Negative; Hinders teacher integration	Negative; hinders teacher integration
Type of use across teachers	Variation, Limited use in 2:1; varied use in 1:1	Limited use of Laptops	Variation in use	Variation in use

Appendix 2: Accountability and Technology Policy Contexts: Virginia & California

Accountability Policy in Virginia

The implementation of the ubiquitous computing projects in the three Virginia schools is occurring within a context of increasing accountability pressures, both nationally and at the state level. The accountability movement encapsulated in the federal No Child Left Behind Legislation (NCLB) has increased the pressure to implement the state-level accountability system with increased emphasis on standardized test results. In Virginia the accountability system is referred to as the SOL program. Between 1995 and 1997 the state adopted statewide curricular standards known as the Standards of Learning (SOLS). The state also revised its accreditation standards (SOAs) and implemented a statewide accountability reporting system. The state then purchased a criterion referenced assessment system. Stakes such as retention, denial of promotion and graduation were recently added to the accountability system. Students not passing the accountability tests were denied graduation in 2004.

The SOL accountability movement represented an increase in the intensity of the politicization of education. As Duke and Reck (2003) asserted in their history of the SOL movement: " If state-dictated curriculum standards, state-initiated standardized tests, state-determined pass scores for the tests, and state-enforced accreditation standards for schools are not clear indications of centralized control and 'big government,' it is hard to imagine what are" (p. 63). The accountability program has led to increased centralization of curriculum and instruction. Grogan and Roland (2003), in their study of 11 exemplary teachers responding to the mandate found: "…The press of time to cover the material

made teachers reluctant to allow student responses to drive lessons, shift instructional strategies, and alter content" (p. 128)

Accountability Policy in California

When compared to other states, California does not have one of the most intensive accountability and high stakes testing environments. But this is changing. The state does hold important school and student requirements for accreditation, grade promotion, and high school graduation. The accountability system is the State Testing and Reporting system (STAR). STAR consists of two components: The California Achievement tests, CAT6, a norm referenced achievement test and The California Standards Test (CST), a criterion referenced test tied to the California State Standards.

In their most recent assessment of state accountability systems, Nichols, Glass, and Berliner (2005) rate California's accountability program as a 2.5 out of a 5-point scale of the amount of pressure on schools and students due to high stakes testing. This rating places them in the middle of pack for the fifty states. The new graduation requirements provide a great deal of pressure on students for graduation. However, there are no uniform state promotion requirements, but individual school districts must set up standards for promotion and retention. In specific school districts in California, thousands of students are being retained based on centralized standards of academic achievement despite huge body of literature shows that retention does not increase later testing achievement and negatively impacts important socio-emotional variables such as self-esteem and school attendance (Holmes, 1989; Jimerson, 2001). Other studies also found that students retained were also more likely to drop out (Jimerson, 1999; Jimerson et al., 1997).

In 1999, California state policy required students to pass the California High School Exit Exam between grades 10-12. A measurement of English and Math, students must pass this test in order to graduate from high school. According to a state report (LAO, 2005) "students who fail either portion of the test may retest up to seven times during the subsequent two years. The test assesses student mastery of the state mathematics standards up to and including algebra and the tenth grade English Language Arts standards." The class of 2006 will be the first class held to this standard. The LAO (2005) reports that for the class of 2006 "almost three-quarters passed each of the subject areas. About 60 percent of low-income students passed at least one of the two portions of the test on their first attempt. Passing rates of English learner (EL) students and special education students were significantly lower."

In 1999, the Public Schools Accountability Act required schools to submit a School Accountability Report Card with an Academic Performance Index (API) based on the Stanford-9 test. Two consequences result from the school's API score: 1)High Performing-Improving Schools Program (HP/ISP) awards schools and staff monetary bonuses if they meet or surpass API growth targets; and 2) Immediate Intervention-Underperforming Schools Program (II/USP) that allows the state to intervene in schools that fail to meet targets for improving test scores. Next we turn our attention to the technology policy contexts in the two states.

Educational Technology Policy in Virginia

The State of Virginia has a history of encouraging technology innovations in schools, which, has in recent years, been tied to the state standards and accountability movement. State initiatives promoting on-line testing have been used to garner support

for technology infrastructure. State policies reflect a commitment to technology in education and a movement toward ubiquitous computing.

In 1996, the state adopted a policy goal of obtaining a five-to-one computer ratio by 2002 (Lemke & Martin, 2004). The state also adopted a policy of universal access to scientific calculators for middle and high school students. In 2000 the state initiated online, web-based SOL instruction, remediation instruction and testing in all of its high schools. This initiative was later expanded to middle and elementary schools. As of 2004, about fifty percent of testing has occurred online (Lemke & Martin, 2004). The online testing initiative has encouraged the development of infrastructure and hardware supporting ubiquitous computing initiatives. "…(T)he Commonwealth appears to be slowly and steadily moving toward selective ubiquitous computing driven by the Standards of Learning, since the key to sustained funding in Virginia is the legislative tie between technological infrastructure and the SOLs" (Lemke & Martin, 2004, p. 2).

Educational Technology Policy in California

The State of California constituted a Commission on Technology in Learning for California K-12 Education Technology that produced a report accepted by the California State Board of Education in 2003(CDE, 2003). The commission reported that the lack of overall educational technology funding and the lack of priority educational technology has received have been impediments to the state reaching the goals of its 1996 Educational Technology Master Plan. They cited the current economic downturn in the state as a factor adversely affecting the state's technology goals. The existence of complex infrastructure needs have also been an impediment to the implementation of the

1996 goals that included a 4:1 student-to-computer ratio, technology as an integral resource for all students and teachers.

Gains in some areas of technology integration have been experienced. A 2002 report found that 96% of schools were connected to the Internet with the average school providing connections to the Internet in 84% of its classrooms (up from 58%). By 2002 the state student-to-computer ratio had fallen to 5.3 to one. Schools and classrooms connected to the Internet rose steadily in California from 2000-2002 (CDE, 2003).

The report also concluded that the state still struggles to close the digital divide. Students attending the wealthiest schools have a student-to-computer ratio of 4.74, as compared to a ratio of 6.13 for the poorest schools. The same type of gap exists with regards to classroom Internet connectivity. The report calls for Ubiquitous access: "Closing the gaps in access to educational technology for students and educators will help all students achieve the State Academic Content Standards, Ubiquitous access will ensure that student and educator work is neither impeded, nor restricted to the school or district site. Districts and schools have approached providing ubiquitous access differently in their local communities" (CDE, 2003, p. 5).