Making Learning Meaningful through Project-Based Learning Using Wireless Laptops in a K-5 Math, Science, and Technology Magnet School

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Overview

The innovation referred to throughout this report is project-based learning using wireless laptop computers. Teachers at Walnut Grove Elementary School are implementing the innovation in grade levels from kindergarten to 5th grade (K-5). This innovation is an expression of Walnut Grove s teachers shared philosophy of teaching and learning that calls for learning activities to be engaging, meaningful, multi-faceted, and linked to everyday life. In 1999-2000 the staff piloted this particular form of project-based learning, which was based on earlier efforts, and 85% of the staff elected to implement the innovation, for a total of 28 different class projects; in the subsequent year, 100% of the staff incorporated the project-based learning approach into their classroom.

Student-directed projects provide the source of these learning experiences. These projects are not initiated within the context of a specific content area; rather, each project encompasses several subjects, including mathematics, reading, science, social science, and technology. With the guidance of the teacher, the class of students select a real-world problem, collaborate together, make connections between related concepts and the problem, and identify possible solutions. Teachers pose questions to students about a variety of topics and work to relate curricula to student interests and life experiences. Teachers regularly provide guidance to students in organizing their ideas using information and communication technologies (ICT) so that the various project components can be identified and a process outlined. Students provide the direction for the project by asking questions and offering suggestions and recommendations for its scope and direction. The organization of the innovation is somewhat flexible projects vary in length from several weeks to an entire semester. Students generate ideas for their projects and manage their own learning and group activities while using ICT as tools to assist them. Students work collaboratively in and outside of class to manage their project, to collect, analyze, and synthesize information, and to present their results. Teachers at Walnut Grove model the use of ICT so that students can also use it with projects.

The whole range of ICT at the school is used with the innovation. The school s ICT includes two Apple Macintosh iBooks (laptop computers) and a desktop DViMac in each classroom. Through a wireless network each laptop can maintain a strong connection anywhere inside of or within 150 feet of the school. Each classroom teacher also has a G3 PowerBook (laptop). In addition, a computer lab houses 25 Macintosh iMac (desktop) computers. Teachers and administrators at Walnut Grove view ICT as essential to supporting project-based learning. The wireless laptops have enabled teachers and students to more seamlessly and flexibly use ICT in the classroom. Teachers integrate ICT into the student projects to structure their learning activities, to allow them to work in collaborative teams on discrete tasks, and to design and produce a variety of products that contribute to assigned projects.

Located in a working-class neighborhood in Seaside, Virginia, Walnut Grove is a primary school founded in 1995 as a mathematics, science, and technology magnet school. Enrollment is open to all students in the Seaside school district and students are selected for admission by lottery. About half of the school s 768 students are African American, approximately 40% are White, and fewer than 10% are either Asian or Hispanic. Fifty two percent of the school s students are eligible to receive free *or* reduced-price lunches. Seaside, Virginia s fourth largest city, has a population of approximately 185,000 people and is located in southeastern Virginia, where the Snake River meets the Lavona Bay.

The Past

The Walnut Grove staff formally adopted the current format of project- based learning during the 1999-2000 academic year but this approach grew from efforts to provide relevant, real-world experiences to engage students in meaningful learning tasks that they began when the school first opened in 1995. The progress of this effort was aided by school leadership, a professional development grant led by a schoolwide leadership team, new ICT purchases the result of a need to be Y2K compliant, and the State s Standards of Learning (SOLs).

Since opening in 1995, Walnut Grove's vision for teaching and learning has gradually developed under the leadership of the school s principal and teachers. The principal handpicked an entirely new staff for the school, deliberately hiring a mixture of novice and experienced teachers and staff who believed that students construct their own knowledge and come to a deep understanding through active experiences. The principal s leadership at Walnut Grove can be defined as strong yet collaborative. Teachers credit him with creating an environment where they could learn and experiment. They also acknowledge that he is willing to share leadership with teachers and staff.

In the years following the school s inception to the current form of the innovation implemented last year, the principal and staff experimented with a variety of innovative instructional movements, including student projects, *character education*, and *service learning*. The principal expressed that their earlier efforts to use innovative teaching approaches was an important precursor to project-based learning. From the beginning, the staff knew they didn't want to stand in front of the classroom and simply deliver information. The staff members efforts to implement project-based learning when the school opened when they wrote some rubrics for each content area for science and math and planned that the children would do some type of a project or product or solve a problem at the end of a two year "loop" to demonstrate their progress on this rubric. Some teachers implemented projects, but their form was not consistent. But the current approach to project-based learning evolved from these early efforts. For example, early on they talked about how kids really need to have real world experiences. But theiry did not consciously label their approach "constructivism" until the latter part of the 1998-99 school year. While staff acknowledged that the principal, Michael Stricklund, established the school's vision when it opened, it is now widely shared. The staff expressed that their predilections toward this vision as formulated during their licensure program, or from their background in early childhood, or inherent in the teaching philosophy they had developed over time.

In 1998, the school s principal and a team of volunteer teachers wrote a successful $150,000 ($50,000 per year for three years) Comprehensive School Reform Demonstration (CSRD) grant from the U.S. Department of Education. To lead the grant activities they formed the Constructivist Teaching and Coaching (CTAC) school improvement team, consisting of 9 teachers representing all grade levels. The ideas the staff formulated for the proposal and the resources they received from the grant award helped to build a consensus around a constructivist view of learning, a particular approach to a project-based model of instruction, and the use of ICT to support it.

Previously, ICT at Walnut Grove was used for drill and practice. The school had four stationary IBM 486 computers in each classroom, containing software and interactive courseware that emphasized technology skill development. The teachers and principal reported that the old

equipment and software were used only sparingly because they did not adequately match their curriculum or their instructional approach. As the school staff members developed a shared vision for project based learning, the type of and purpose for technology evolved at Walnut Grove. Because of a need to beY2K compliant, the school staff had to purchase new ICT tools. The staff members shared teaching philosophy and values, their collaborative teaching culture, and a recent school-wide commitment to project-based learning provided the staff with a strong base from which to select and implement ICT tools.

At the beginning of the 1999-2000 academic year the school installed a wireless network with an Apple Macintosh platform. The current ICT arrangement is a combination of wireless laptops and desktop machines containing integrated tool software packages. The generous support of the CSRD grant (funding teacher release time and the customized professional development) supported the staff in planning, training, and learning to use the ICT as a support to project-based learning.

About the same time the CTAC was crystallizing the school s approach to project based learning and selecting new ICT, Walnut Grove received a warning from the State Department of Education in 1999 due to low scores related to the Virginia Standards of Learning (SOLs). Consequently, the principal, the CTAC committee, and the teaching staff made it a major priority to align the district s curricular content and requirements and its use of ICT to the state s SOLs. This effort has led teachers to work together to develop teaching activities that address these standards. The CTAC published a written school improvement plan that guided the implementation of project-based learning and articulated how ICT could be used. This document required teachers to complete a weekly plan, identifying the SOL to be addressed and outlining the concepts, skills, questions, and assessment strategies related to the curriculum area. The plan also highlighted the importance of professional development for all teachers and the requirement that they use ICT tools and collect evidence of student work using spreadsheets, databases, word processing, multimedia, and communications tools that would be shared at quarterly grade-level instructional meetings. Teachers submitted their weekly lesson plans to the principal and shared them with their colleagues during their weekly grade-level meetings, when they discussed curriculum resources, integration plans, student strengths and weaknesses, and alternative instructional strategies. In general, teachers expressed satisfaction with the current ICT infrastructure because it was better aligned with the school s instructional goals and it provided greater flexibility and reliability than the previous platform.

The Present

Project-based learning at Walnut Grove primarily changes how the curriculum is delivered and organised. The projects do not represent the entire curriculum but instead serve as application and example for parts of it. Student interests and questions drive the scope and directions of the projects but the teaching staff at Walnut Grove has exerted considerable effort to link the district curriculum goals and content to the Virginia Standards of Learning (SOL). The result is a range of project-based learning teaching activities that address these standards.

Three distinct phases of project implementation are outlined and adhered to throughout the year: planning, fieldwork, and celebration of learning. In the planning stage, students brainstorm and pose questions in order to identify a relevant problem to study. In this manner, students help to determine the content of the curriculum. The fieldwork and celebration phases

provide opportunities for students to work together to create and share what they have learned. In each phase, students and teachers use ICT to organise their projects, collect information, analyze problems, make calculations, and create products that describe their projects. At the end of each phase, students create a project storyboard that is displayed in the school auditorium for others to see at a project fair. At the end of the celebration phase, held in late spring, the community was invited to view projects and hear presentations made by the students.

In embracing their vision of constructivism and project-based learning, classroom interactions between the teacher and the students and among the students have changed. Rather than deliver information, teachers pose questions to students so as to relate the curriculum to their interests and life experiences. Through questions, teachers are able to elicit relevant information from students. In a 2nd grade class we observed, the innovation teacher began the class by asking a series of questions about how their local community had experienced change and growth. Throughout a 10-minute discussion, she posed many questions in an attempt to get the students to focus on their project, which was to build a poster describing how the local community had changed in recent years. Students also interact more often with one another as they work on their projects. Throughout the course of a project, students might perform specialized tasks on a project committee or rotate through different committees, performing different functions on them. In a 3rd grade project on light rail systems, for example, students rotated between different tasks given to a map committee, a research committee, and a field trip committee. For the 5th grade flowers and plants project, students performed specialized tasks throughout the project collecting survey data on the preferences of potential customers, cultivating the plants, developing and implementing an advertising campaign for the plant sale, or conducting research on how to care for the different plant varieties. The school-wide adoption of project-based learning has created new and expanded responsibilities for students that had not existed before.

The teachers in Walnut Grove regularly modeled how ICT could be used in completing projects. With their laptop computer, many teachers use a variety of software applications to present material or to model an activity that the students are to undertake. For example, after the discussion in which the 2nd grade students identified changes in their community, they spent time creating an Excel spreadsheet at four laptop computers situated around the classroom. Working in triads they were to create a tool that would help them tally the results of a survey they were going to administer in their neighborhood. The teacher regularly provided guidance and feedback to students in organizing their ideas and completing the task of creating a spreadsheet. In their groups, students contributed to this process by answering questions, asking additional questions, giving advice to each other, and offering suggestions and recommendations about the projects and the operation of the ICT. In a 4th grade classroom that was observed, the teacher began the class by giving a multimedia presentation about fractions (1/2, 1/4, etc.) that showed squares being divided into halves and into fourths. As she presented this lesson, students watched while sitting in pairs. The next day, the students worked at laptop computers around the classroom, using the same multimedia software the teacher used the day before to create slides of whole squares representing fractions. The math concepts presented were to help the students better grasp some of the mathematical calculations they would encounter in using spreadsheets.

In a fourth grade class conducting a project on flowers and plants, students used spreadsheets to

tabulate survey responses collected from the community on their preferences for flowers, including types, colors, and habitat. This information was used later to help the students manage different aspects of their plant "business". Each student in class also used spreadsheets to record regular measurements of the plants being cultivated at the school, to place them into categories, and to systematically monitor the growth of their own plants. Here is how one student described how spreadsheets were used, when we had seeds we got into groups and planted them and mixed the soil up and each day we switched plants and we had to do spreadsheets and we had to say, what is the average height, what they looked like, what is the date, how many days will they come up..." (Student Focus Group, T108). Students in this class also used ICT to collect information on the Internet on how to care for the growing plants.

The current ICT arrangement at the school is wireless laptops containing integrated tool software packages. This current set up of ICT is used to design and create products and presentations related to the class projects underway, rather than for the drill and practice of facts, like the previous ICT configuration at the school. Each classroom contains 3 wireless laptops (1 that also serves as the teachers' personal productivity tool) and a desktop machine that are connected to the school-wide network and the Internet. Each classroom is also equipped with a color printer and a telephone. Additional iBooks can be borrowed from the lab or other teachers and there are 12 additional iBooks available for checkout in the technology lab. Because the iBooks are portable and battery-powered, they can be used anywhere in the classroom and still be connected to the Internet, as long as they are within the range of the wireless system s ceiling-mounted teleport. Walnut Grove also has 25 stationary iMac computers installed in the technology lab, where a wide range of peripheral equipment is also available. Each computer contains integrated applications software (e.g., ClarisWorks for Kids), multimedia software (e.g., HyperStudio, PowerPoint), organizing tools (e.g. ThinkingMaps) and communications tools for email and Web browsing.

The wireless and laptop configuration is a key characteristic of the integral use of ICT for project-based learning. Like the portability, the wireless networking of the laptops can be viewed not only as an added convenience, but also as an additional feature that enhances the value of the ICT. The wireless network enhances the usability and value of laptops by providing a network connection wherever they are taken in the school, including up to 150 feet outside of the school. In our visit to the school, we observed student using their laptops in classrooms, in the halls, and in the library. The portability of the laptops was not diminished by their needing to be tethered to the wall for a network connection. Thus, teachers could concentrate on the placement and groupings of students that made the most sense for the learning, not based on hardware needs. Furthermore, when to gain additional computers they borrowed other classroom teachers machines, they didn't need to worry about loading and moving around files because they would always be able to access and save materials to a central network location.

While the laptop and wireless characteristics make it easier logistically to use the computers in the classroom, the tool software is probably the most important reason that teachers and administrators at Walnut Grove view their use of ICT as essential in supporting project-based learning. The classroom computers combined with integrated software applications also provided a range of flexible tools that can be creatively used in project-based learning. Using the drill and practice software on the old platform was not conducive to the prevailing philosophy of teaching. In the principal's words, "we saw those software applications as delivery of curriculum..." (Principal Interview, T102). This might involve generating a graph

based on collected data, or using an application to create a product. Typically, one student worked at the computer while one to two others in the group offered suggestions or advice about completing the task. From our observations of pairs of students engaged in work at a cluster lap top computers, information sharing and offering of suggestions flowed among the students working near one another.

The school is unique in its district because it has two technology support staff who provide software integration support, technical support to teachers and students, training for students, and trouble-shooting for the network. A minimum of 36 hours of training is required for all district teachers to keep the school district-provided laptop; the district does provide some learning opportunities for teachers to meet this requirement. This school initiated its own customized class to meet the district requirements for ICT professional development. FutureKids, an outside vendor provided a 45 hour hands-on class for teaching staff on computer basics, telecommunications, multimedia, and instructional unit creation. The FutureKids class helped teachers to develop increased proficiency in using ICT to support project-based learning. As one teacher put it, I know I ve learned a lot [about ICT]. It has improved my teaching, I think, especially taking the FutureKids class. I m creating things. It gives me the opportunity to create things along with my students so we re kind of learning together...(Teacher Interview, T104). The principal also felt that this class, held after school onsite for three hours a week, was key to his teachers learning to use ICT and apply it as a support to project based learning.

FutureKids training solidified the collaborative learning model that is the vision of the school s professional development of teachers in the use of technology....I feel that the Futurekids curriculum allowed the teachers to actively learn, practice, and implement the use of technology as a tool to increase student learning. (Principal)

As of the site visit, 38 of the 40 teachers at this elementary school had taken the intensive FutureKids training; the final two teachers were planned to enroll in the next offering of the class.

One main problem emerged during the first year of implementing the innovation. Project-based learning demanded additional work time and this initially created some stress for the teaching staff. According to one teacher, ¼At the beginning of the school year- we were really overwhelmed¼¼ (Teacher #3, Teacher Focus Group, T107). In an external evaluation completed at the beginning of the 1999-2000 school year, a number of teachers expressed concern about the extra burdens they had to carry in implementing the CTAC plan. In addition, in the middle of the same school year, teachers had to make the transition from using a Windows-based platform to using the wireless Apple-brand laptops. This required additional time for them to master a new operating system and some new software applications. Because of these pressures, the CTAC team decided to make implementing project-based learning voluntary during the pilot year. Teachers who did not choose to undertake a project in their classroom could ¼shadow¼ another teacher who did so. Teachers reported to us that having it posed to them as a choice reduced their stress. In the end, a majority of them, 85%, participated the first year. As one teacher put it, "We're here [doing project-based learning] because we all buy into it so I think we all have ownership..." (Teacher #5, Teachers Focus Group, T107).

One barrier the teachers have had to work around to is the finite amount of ICT resources available to support project-based learning at Walnut Grove; every classroom teacher is guaranteed access to only three laptops and one desktop computer. To address this, teachers

group students into pairs or triads. To reduce the number of rotations required for all the groups of students to get a turn on the computer, the teacher borrows additional laptops from other teachers not using theirs or can check out a set of twelve laptops out from the computer lab.

Hypotheses

Hypothesis 1:

Technology is a strong catalyst for educational reform, especially when the World Wide Web is involved. The rival hypothesis is that where true reform is found, technology served only as an additional resource and not as a catalyst, that the forces that drove the reform also drove the application of technology to specific educational problems.

Evidence in support of the rival hypothesis:

Teachers had been over five years evolving in an approach to instruction that represented a constructivist model of learning. The school staff members have investigated a variety of instructional "movements" that have all contributed in small part to the current iteration of project-based learning. There have been many opportunities for teachers to go to conferences and they would share information with others upon their return. "It kept moving forward, but kind of inching forward---not really to the point where it was full blown. [Principal]." The principal and several teachers expressed that the project-based learning as they were implementing it (i.e. following a particular model) brought together in a coherent way many innovations they'd tried over the last five years.
During this five-year period they made some use of a very different ICT set-up. At the time the school opened, in 1995, they received approximately half a million dollars to wire the school and equip it with current hardware. The result was state-of-the-art educational technology, at least at that time: 4 stationary terminals located in the back of each classroom (IBM-486 Windows platform machines) and skill development software (e.g. drill and practice courseware). However, the teachers found this arrangement and software was not very conducive to the instructional approach they were moving towards and consequently, it was not used very often. When Y2K presented an opportunity to chose new ICT, they selected hardware and software that was better aligned with the school s instructional approach. Now, Walnut Grove s vision for ICT use is tied directly to their use of project-based learning and is driven by their goals of addressing their State s Standards of Learning as well posing relevant problems to students and valuing students perspectives about learning.

Evidence in support of hypothesis 1:

The flexible arrangement the wireless laptops allow, along with the access to tool software and the Internet, is clearly a benefit to their educational reform and serves as a further support to it. However, the staff does not describe ICT as a catalyst to their innovation, instead indicating that they could do the instruction without ICT; at the same time they clearly appreciate the capabilities and other benefits it provides. In that sense, you might describe it as a catalyst for continuation, or for spurring additional efforts even if it was not a catalyst for adoption or initial implementation of the innovation.

Hypothesis 2:

The diffusion of the reform (and therefore of ICT) followed the traditional diffusion pattern for reforms and innovations, as outlined by Rogers (1995). The rival hypothesis is that technology functions differently from traditional innovations and reform and that therefore different diffusion patterns occur.

Evidence in support of the rival hypothesis:

The school opened with a new staff five years ago, and the members were hand-picked as a new group. The principal made a concerted effort to select staff who held a view of learning consistent with the vision he had formed for the school and who would teach in an instructional style compatible with this. Consequently, the vision on teaching and learning in the school is rather uniform: students need active experiences in order to construct understandings and the topics students study should be shaped by their experiences, interests, and needs. Teachers respect the need for students to develop a sense of community in the classroom---especially to create the collaborative qualities necessary to support project-based learning. As a result, students stay together with a teacher for two years (they call this looping), and they use strategies like class meetings to develop a sense of community in the classroom and to build up students' collaboration skills.

Because the staff was all specifically selected for this school, they do not represent a cross-section of the range of teaching philosophies you might expect to find in a regular school where the staff members gradually hired on over several years time. This school s staff definitely recognized how their shared views on teaching approaches supported the successful implementation of this reform. So, using Rodgers' labels (1995), you might say that they were all selected because they were innovators or early adopters for the key components that led to this instructional reform. When the school staff started 5 years ago, the staff members shared a similar philosophy. This philosophy and its expression have evolved, but the staff is still remarkably similar in their pedagogy.

For example, when the CTAC leadership team presented the implementation of project-based learning as voluntary, 85% of the school's teachers chose to participate during the pilot year. Rodgers' model might predict that just innovators or early adopters might have chosen to participate (between 2.5%- 16%). We attribute this high rate of participation to the factors in place that we identify as sustaining this innovation. That is, the peer-led, constructivist approach to staff development, including the opportunity to attend conferences, and a strong collaborative spirit among the teachers.

Evidence in support of hypothesis 2:

While there is remarkable unity in their educational philosophy, staff members we spoke to do acknowledge that some among them, for example the principal and the CTAC members, have provided leadership for the progress they've made at the school in implementing project-based learning. In that sense, within this relatively uniform group, you see, as Rogers (1995) diffusion model would predict, differentiated rates of implementation.

Hypothesis 3:

Successful implementation of ICT depends mostly upon staff competence in the integration of ICT into instruction and learning. This hypothesis assumes that teachers mediate ICT applications when they are successful, and that ICT s academic value relates positively to teacher competence. The rival hypothesis is that the school technological infrastructure and student ICT competence rather than staff competence determine ICT implementation outcomes.

Evidence in support of the rival hypothesis:

The infrastructure of the ICT at this school made clear contributions to the teachers ability to use it to support project-based learning. Under the previous arrangement with the stationary IBM 486's, students had to move to the back of the classroom and try to create space around the computer in order to use software. According to teachers, this arrangement as well as the software on the computers was limiting. The wireless laptops enable teachers and students to seamlessly and flexibly use ICT in the classroom. In describing the flexibility of the laptops one teacher said "...it's convenient having the iBooks that they can take back to their seats because they can talk to the person beside them about what they are doing on the iBooks or somebody can come over and help them..." (Teacher Interview, T104). The wireless networking of the laptops further enhances the value of the ICT by providing a network connection wherever they are taken in the school. Thus, teachers could concentrate on the placement and groupings of students that made the most sense for the learning, and not be restricted by hardware and software needs. Software, files, and Internet resources were always available. In addition, the laptops allow teachers to share these finite hardware resources, they easily move from classroom to classroom---wherever they are needed.

The students technology skills also support the use of ICT during project based learning. The classroom teachers do not have to take time away from other classroom activities to directly teach ICT skills because the technology integration specialist in the school does this in the school's technology lab. He works with the classroom teachers to learn which specific software applications are demanded by classroom project activities. Based on the type of projects, the students might learn to create a database, use a spreadsheet to produce a graph from collected data, search the Internet for information, create a variety of graphics, view a mathematical or a scientific simulation, create a slide presentation, produce a word-processing document, or take a virtual field trip on the Internet. Beginning in kindergarten, Walnut Grove students are introduced to and use ICT to the extent that they are able. The students use of technology becomes more sophisticated as they progress through the grades. According to a kindergarten teacher:

I know our second graders are actually putting the databases and the spreadsheets into their projects. For kindergarten projects, the technology---really it s me [who operates the computer]....But it s very easy to see how by second grade it becomes their product and not the teacher s....So right now [in kindergarten] a lot of the technology that you would see is the work of the teacher. We have one brochure but I had to type it in and print it out and all (Teacher Interview, T101).

The school staff members focus on developing students ICT skills was reinforced by the

technology SOLs students were to meet. These skills were assessed through a paper and pencil test.

Evidence in support of hypothesis 3:

In order to receive an Apple PowerBook laptop for classroom use, the school district required that a teacher had to undertake a minimum of 16 hours of training in ICT and integration, called Phase I by the district. The district provides for this phase I training in ICT use and integration during a summertime Professional Development Institute. They also offer Phase II training. Because the CTAC and principal valued more intensive technology integration training, they arranged for an outside vendor (FutureKids) to provide a 45 hour course. During the time of our visit the third cohort of teachers was just completing the course; only two of the 40 teachers had yet to take the FutureKids course.

The FutureKids staff development program helped teachers to develop increased proficiency in using ICT. Project-based learning requires teachers to know the capabilities of ICT packages so that they can easily be matched to and utilized for the instructional setting. Through the FutureKids professional development teachers at Walnut Grove learned about grade level-appropriate activities using application-based ICT resources. Teachers completed assignments that required them to choose appropriate tools to support students design and production of products that would reflect their knowledge and ability.

Having a collaborative teaching culture at Walnut Grove has also made project-based learning a platform from which teachers can develop an enhanced view of ICT and its role in learning. One teacher described the benefits this way: It benefits us because we work together and if we have problems with learning, we re able to work and figure out what those problems are, and then get help from somebody who may have the answer to it. We work together at celebrating those things that are positive and help children with their learning... (Teacher Focus Group, T107). As a further support to this training and collaboration the school made it a priority to divert funds to employ two technology integration specialists in school building; whereas other district schools had one, or none at all.

Hypothesis 4:

Gaps in academic performance between high and low poverty students will not increase when all students have equal access to ICT. The rival hypothesis is that equal access to ICT will lead to more advantaged students increasing the performance gap with disadvantaged (high poverty) students. Evidence in support of hypothesis 4:

In 1999 the school s scores on the Virginia Standards of Learning assessments (SOLs) were low and as a result the school received accreditation with warning and received additional state funding to supply remediation for low-scoring students. The principal implemented several remediation programs, including some that were technology-based. When the staff implemented project based learning, they took care to make sure the SOLs were addressed. Administrators and teachers all concurred that project-based learning benefited all students who have participated: they show enthusiasm, develop ICT skills, and have a deep understanding of the topics they study for their project. From 1999 to 2000 the school s SOL scores improved

markedly in nearly all areas (reading, writing, mathematics, science, and computer/technology) (see Table 1).
Fifty-two percent of the school s students are eligible for free or reduced-price lunch, which reflects low family income levels. The African American students at Walnut Grove make up just over three quarters, or 76%, of the total number of students who receive free and reduced lunch, the only measure of income on which the school has information. While all students made gains in these areas, of particular concern for the staff were the African American students, whose score were comparatively much lower. In 2000 theAfrican American students made equal or higher gains compared to other students. During the pilot phase, the year of our visit, approximately 85% of students, representing every grade level (K-5) at Walnut Grove participated in project-based learning.

Table 1.
Walnut Grove Elementary Disaggregated 1999-2000 SOL Test Results, Percentage of Students Passing SOL Test

GRADE 3						TEST	GRADE 5					
Spring 1999		Spring 2000					Spring 1999		Spring 2000			
Black	Non-Black	Black		Non-Black			Black	Non-Black	Black		Non-Black	
%	%	%	gain	%	gain		%	%	%	gain	%	gain
15	64	28	+13	69	+5	**English: Reading and Writing**						
						English: Reading, Literature, Research	31	63	49	+18	76	+13
						English: Writing	49	82	53	+4	86	+4
33	81	44	+11	82	+1	**Mathematics**	18	43	55	+37	80	+37
24	64	46	+22	78	+14	**History & Social Science**	30	58*	23*	-7	90*	-8
28	81	56	+28	82	+1	**Science**	32	79	68	+36	90	+11
						Computer/Technology	72	90	85	+13	93	+3

* test taken at grade 4

Evidence in support of the rival hypothesis:

None.

Hypothesis 5:

Successful implementation of ICT will lead to the same or higher academic standards in spite of the low quality of many ICT materials. Academic standards are a function of teacher and school expectations and not of the standar5ds of textbooks, ICT materials, and the like. The alternative hypothesis is that ICT use will lead to a lowering of academic standards as students

spend more time on marginally beneficial searches and in browsing poor quality web and courseware content.

Evidence in support of hypothesis 5:

In addition to these test score improvements, the Walnut Grove Elementary School teachers and administrators identify additional outcomes that both high and low income students gain as a result of project-based learning. This includes their learning to use a wide variety of ICT. They use integrated software packages (e.g. ClarisWorks for Kids, AppleWorks) to store information, to generate graphs and charts, and to create written documents. Students use the ThinkingMaps software package to map out their ideas and to organize their projects. They use Internet browser software to navigate the World Wide Web and conduct Internet research. They also use multimedia software applications to design products and present slide shows of what they have learned in projects. Students are actively involved in designing and creating products that are used directly in the projects. This might include project/story boards on which to display information relevant to their project or the use of hands-on manipulatives, primary sources, or raw data.

Project based learning has created new opportunities for students to interact with teachers and other students in different ways. Students are not only responding to instructions from their teacher, but are generating ideas that help to define the projects they create as a class. With project-based learning, there is an expectation that students will play an active role in learning and contribute to this process. Student questions and suggestions help the teacher to identify an appropriate topic on which to focus their project. Students work collaboratively with one another in order to complete their project. In some cases, students provide solicited or unsolicited assistance to their assigned partners or small groups, depending on the need. In each group, students are assigned different functions that they perform under the monitoring of the teacher. Throughout the course of a project, students either specialize in the work of their project committees or the members rotate, performing different functions on different committees. Confirming teacher reports, we observed to a wide range of project presentations that demonstrated the communication skills of the students.

In addition, project-based learning appears to have a connection to improved student attitudes toward learning, as reported by both teachers and students. Teachers also report that student motivation has also increased with the use of project-based learning. Teachers in the teacher focus group reported that students have exhibited increased engagement and participation in their class projects and a deeper understanding of the content and process of learning. Students also reported that project-based learning made learning fun and more consequential. One female student described this saying, Last year all we really did was write down in our notebooks and that is how we kept up with the information we learned. But now we get to experience [it] and we get to touch more than hear; we can keep it in our brains and it is, like, stuck... (Student #2, Student Focus Group, T105).

In summary, project-based learning at Walnut Grove is contributing to improvement in a range of student competencies that were consistent with the high standards or expectations of the teachers.

Evidence in support of the rival hypothesis:

None.

Projection To The Future

The reform at this school appears sustainable because of the teaching philosophy shared by the school s teachers. These teachers were specifically screened for their philosophy on and knowledge about a constructivist view of learning and teaching. This results in a shared feeling about the need for and relevance and merit of project-based learning. The principal as well as other teacher-leaders are committed to supporting and spreading the use of project-based learning. It appears that one of the chief reasons project-based learning is being sustained and embedded within the broader teaching culture at Walnut Grove is that teachers share leadership in the reform and drive its implementation. By the second year the instructional reform transferred to all teachers within the school.

The sustainability of project-based learning at Walnut Grove is also tied to the mixture of funding mechanisms that support its implementation. The district's negotiation of the teacher contract providing each teacher with a laptop so long as they participated in ICT professional development is important. The school district has established a private/public sector partnership that resulted in city funding of the school division's technology plan for $45 million over a six-year period. The school district's technology planning has also taken advantage of some outside funding resources, including a range of federal funding mechanisms (i.e. E-rate, Community Technology Centers grants). This diversified revenue stream for ICT supports the sustainability of its use in project-based learning in this setting.

Federal funding for ICT played an important role in supporting the innovation at Walnut Grove. The $150,000 Comprehensive School Reform Demonstration (CSRD) grant from the U.S. Department of Education administered by the CTAC school committee funds a range of activities that support the school's adoption of project-based learning. Having a flexible source of funding like this has allowed Walnut Grove to provide a rich environment to support the adopted innovation.

A policy at the state level that has influenced the developments at Walnut Grove is the Virginia Standards of Learning (SOLs). These standards are minimum learning objectives for students in all content areas from grades K-12. By 2007, all students must meet these standards in order to graduate. And school accreditation is dependent upon a school-wide 70% pass rate. The high-stakes nature of these standards (i.e., they determine student graduation and school accreditation) poses a threat to the project-based learning. However, at this point it seemed an expression of Walnut Grove's dedication to project-based learning that the teachers planned the project and then identified where SOLs fit rather than fearing they couldn't fit in the project because they needed time to cover the SOLs. This strategy appears to have yielded some success given the improved SOL scores Walnut Grove received this year. Time will be the ultimate test of how project-based learning is affected by the SOLs, but we conjecture that should the pressure to raise students' SOL test scores increase, it could threaten the sustainability of this instructional reform.

Additional school-level policies and practices contributed to the institutionalization of the innovation. Implementing project-based learning is a time-intensive operation in which teachers are stretched in order to plan, structure, and monitor student learning. Teachers at Walnut Grove initially expressed concern about the amount of time a project takes to implement. They

were very enthusiastic about attempting to implement projects during the implementation year because it was presented as a free choice. Once their students became engaged in the project, the teachers were motivated enough to continue with it even if it was demanding. Although teachers view projects as a major time investment, they are coping with the increased demands and recognize the added benefits.Looping allows teachers to get to know their students better and build a collaborative community, essential elements that support project-based learning. The professional culture is also strengthened and enhanced by the professional development offerings available to teachers.

As for scalability elsewhere, having students active during the learning process and constructing understanding is part of the national dialogue about how best to teach in the U.S. But, clearly the philosophy of teachers either makes them more or less well suited to implementing this instructional reform. Even if inclined to teach in this fashion, teachers need some special training. This threatens the transferability of the instructional reform on a widespread scale.

There is general agreement among teachers at Walnut Grove about project-based learning and its benefits. When asked, teachers at Walnut Grove said that their common philosophy was an important driving force behind their willingness to put in the extra time required to make project-based learning work. Many of them explained that they were so pleased to be doing something that they had previously not been able to implement in such a complete and successful manner. This suggests that project-based learning supported by ICT was something that they had always been working toward, not a practice that they had recently adopted. It is likely that teachers in another school setting without a history of implementing new practices would not be willing to deliver the efforts necessary for carrying out project-based learning. There would be, therefore, a greater likelihood of adopting project-based learning in a setting where the teaching staff holds similar beliefs about learning and teaching as do the principal and staff at Walnut Grove.

An important factor influencing the transferability of the project-based learning to another setting is the existence of funding that can support project implementation, especially professional development. The principal acknowledged the boost this grant provided but explained how he would have paid for the same offerings through other district resources had the grant not been awarded to them. His assessment was that a school can always reallocate or find funds to support its priorities. In this case, the grant funds served as a direct, and generous, set of resources for the school. Whether through external grant funds or local operating funds, the funding of staff training in the use of ICT for instruction is of paramount importance in transferring project-based learning with ICT. As the superintendent stated, ...you've got to have a steady funding stream to take care of the continuous technology education that you have to provide... (Superintendent Interview, A111).

The demands of project-based learning require a flexible ICT infrastructure and a robust operating platform in order to see it transferred to different settings. At Walnut Grove, the selection of the wireless network, the portable laptop computers, and the integrated software applications provided the needed flexibility and the power that could support the adopted innovation. A district technology administrator commented on how Walnut Grove had evolved in the ICT they wanted as the school vision and teaching philosophy became more coherent and focused on a constructivist model of learning:

...they [Walnut Grove] had intellectually outgrown that stuff that we put in [the original stationary, Windows-based platform with courseware]. So then we had to have a school

discussion of where do we want to go from here in terms of hardware and software that you re looking for to meet your needs. And we ended up with what we have down there now. I think it was kind of a startling statement for me to hear from a principal that, We ve outgrown it not because there isn t enough disk space but [that they] have outgrown it instructionally. That s kind of a very different statement... (District Technology Administrator Interview, A110)

This school's experience suggests that any attempt to implement project-based learning at another site will require coordination and a clear vision for how the ICT will be used to ensure that it is appropriate for project-based learning.

Closing
30 minutes
Reflection
Class Meeting
Sharing
Agenda Books
Planning

Appendix A: Methods

Description of the amounts and types of data collected

Interviews Conducted

with teachers (approximately 45-60 minutes each)

- One kindergarten-first grade teacher,
- one second-third grade teacher,
- one fourth grade,
- teacher focus group (comprised of two k-1 teachers, one 2nd -3rd grade teacher, and one 4th 5th grade teacher)

with parents (approximately 15 minutes each)

- two total, both of fourth grade students. In addition, two of the teachers we interviewed had students in the school.

with students (approximately 30 minutes each)

- student focus group (comprised of five fourth graders)

with building administrators (approximately 45-60 minutes each)

- Principal
- Technology Integration Specialist
- Technology Assistant

with district office administrators (approximately 45-60 minutes each)

- Superintendent of schools
- Executive director for Technology Information Services
- Operations Manager (for ICT)

Observations Conducted

of classrooms (approximately 45-60 minutes each)

- Kindergarten (also videotaped)
- Second grade (also videotaped)
- Fourth grade (also videotaped)

of student presentations (approximately 10 minutes each)

- Approximately 13 different student group presentations (also videotaped)

Site Documents Collected

- Class Project Boards & Presentation Schedule, May 18, 2000
- CTAC Meeting Notes for AY99-00
- Daily Schedules of Interviewed Teachers
- FutureKids, Inc., School Technology Solutions Professional Development brochure
- Math, Science & Technology Magnet Program at Walnut Grove, Tri-fold brochure
- School Newsletter, Oct. 99 May 00
- Seaside K-5 Magnet School Project Summary: Hardware, Courseware, Training & Support, Budget Estimates
- Seaside Public Schools Instructional Computer Network Hardware and Software Specifications
- Seaside Public Schools Network Cable Specifications
- Seaside Public Schools Strategic Plan, A six year vision for the future 1999-2005
- Seaside Public Schools Technology Implementation Plan, October 9, 1996
- Seaside Public Schools Technology Plan, December 1999
- Seaside Public Schools Technology Training Summer 2000 Information Packet
- Walnut Grove Elementary, Full color brochure
- Walnut Grove Elementary, One page info sheet
- Parent, Student, Teacher Contract
- Percentage free & reduced lunch
- Printing Materials for Walnut Grove 1995
- Report cards
- Resource Schedules, Cafeteria Schedules, Testing Calendar, Committee Responsibilities Calendar 1999-2000
- Software List
- Staff & School Map 1999-2000
- Standards of Learning for Virginia Public Schools
- Technology Program Activity, Memo from Executive Director for Technology Information Services

Appendix B: Teacher ICT Practices Survey Results

Case 100, N=18 (of 40 teachers)

How comfortable are you with using a computer to:

	1 very comfort-able	2 comfort-able	3 somewhat comfort-able	4 not comfort-able
	%	%	%	%
Write a paper	94%	6%	0%	0%
Search for info on WWW	89%	6%	6%	0%
Create, maintain web pages	11%	22%	39%	28%
Use a data base	44%	33%	17%	6%
Send & receive e-mail	100%	0%	0%	0%
Programming	0%	0%	18%	82%
Draw picture or diagram	53%	29%	18%	0%
Present information	72%	22%	6%	0%

For work you assigned last year, how often did your students:

	1 1+ times weekly	2 1+ times monthly	3 a few times	4 never
	%	%	%	%
Use WWW	22%	39%	33%	6%
Create web pages	0%	0%	11%	89%
Send & receive e-mail	11%	6%	44%	39%
Use word processing	56%	39%	0%	6%
Use computer for games	17%	17%	33%	33%
Use a graphics program	39%	39%	17%	6%
Join on-line forum or chat	0%	0%	11%	89%
Use presentation program	0%	0%	61%	39%
Use instructional program	0%	6%	24%	71%

Rate your ability to use a computer

	1 good	2 fair
	%	%
Ability to use computer	89%	11%

Experiences last year

	1 yes	2 no
	%	%
Graded student computer use	38%	63%
Made Web site for my class(es)	6%	94%
Involved in virtual, on-line course	19%	81%
Students collaborated via Web	12%	88%

How much freedom did you allow students in locating WWW sit to visit?

		1 no restrictions	2 some restriction	3 Only certain sites
Students' web restrictions	Count	2	6	8
	%	13%	38%	50%

Computer use in classes last year

	1 All	2 Most	3 Some	5 None
	%	%	%	%
% of classes devoted to computer use	33%	44%	17%	6%
% of computer use done individually	6%	44%	44%	6%

Computer use at home

	1 1+ times weekly	2 1+ times monthly
	%	%
Amount of computer use at home	78%	22%

Collaboration with other teachers via WWW

	1 yes	2 no
	%	%
Using ICT for collaboration	28%	72%

E-mail messages sent daily

	1 12+	2 6-11	3 1-5
	%	%	%
Daily e-mail messages sent	17%	6%	78%

Computer Expertise Index

	0 none	1 1	2 2	4 4	5 5
	%	%	%	%	%
Number of computer activities done	13%	20%	20%	27%	20%

Appendix C: Supporting Evidence

None to include