beyond gaming

a technology explosion in early childhood classrooms

by Nancy Hertzog and Marjorie Klein

"Oooh, why don't you use Wingdings? That's cool!"

"Look at that! It's glopping! Let's make it glop all over!"

These 5-year-old children are using new vocabulary to describe font styles in Simple Text and to illustrate their pictures using the paint tool in Kid Pix (Broderbund). They are mentoring each other on the use of those programs and giving ongoing evaluative feedback as to the quality of their creation.

The phrase "Do you know where your child is?" takes on a whole new meaning in today's generation. Our children can be at home, yet be anywhere on the Internet, playing games in real time with other students across continents. They can be immersed in a simulation and be trudging through the Old Frontier or battling soldiers on the beaches at Normandy. This generation of students, now referred to as "digital natives" in the computer industry, is different from their "digital immigrant" parents. Digital natives were born into a world where personal computers are used as everyday tools. Their immigrant parents acquired computer literacy similar to learning a second language. Digital natives are computer savvy and they are *everywhere* on the computer.

Thus, technology is playing an important role in the lives of our children. How can we channel their curiosity and use technology to help them grow intellectually, socially, and emotionally? How do we integrate technology into our instruction to go beyond consumers and gaming to using technology as tools for creative production?

In this article, we share examples of how we have integrated technology into the curriculum. We demonstrate how the impact of technology has personalized and differentiated instruction, and we provide some suggestions for others and conclude with possibilities for the future.

Research

Clements and Sarama (2003), in their summary of the research about technology for young children, discuss the value of computers in five areas: social and emotional development, cognitive development and learning, creativity, language and reading, and mathematics. In the social and emotional domain, they maintain that research and practice indicate that

> computers can serve as catalysts for positive social interaction and emotional growth. . . . Computers can facilitate both social and cognitive interactions—each to the benefit of the other. Good software encourages children to talk about their work as well as engage in more advanced cognitive types of play than they do in other centers. (pp. 34–35)

According to Clements and Sarama (2003), "Whether used to read or write; to acquire knowledge and insight into science, mathematics, and other areas; to express oneself; or to learn content in a new medium, computers can support the expression and development of creativity" (p. 35). These researchers found that preschoolers' spoken words per minute were twice as high at the computer than at any other activity, including play dough, blocks, art, or games. According to Siegle (2003), "Some of the best programs begin with a blank screen upon which students can apply their creative imagination and talents" (p. 17).

Siegle (2005) reported several research studies that described benefits of using technology. According to Schunk (2000), as cited in Siegle (2005), "When technology is used effectively, it creates an active interaction between learner and content. The complexity of these interactions increases with the level of student talent" (p. 18). Jonassen, Peck, and Wilson (1999) noted that students who use technology for creative production "engage in much more meaningful learning" than those who are "receivers from instructional-technologies" (p. 18). Jonassen et al. made a distinction between using technology to teach and using technology for critical thinking. When computers are used to teach, students use recall and memorization. However, when computers are used as "Mindtools," students must "conceptualize, organize, and solve problems" (Jonassen et al., p. 152). When students use Mindtools, they "function as designers—analyzing phenomena in the world, accessing information, interpreting and organizing their personal knowledge, and representing what they know to others" (p. 153). Thus, when used appropriately, technology has the potential to make a substantial positive contribution to young children's learning. This higher order thinking is particularly useful to challenge gifted students.

University Primary School

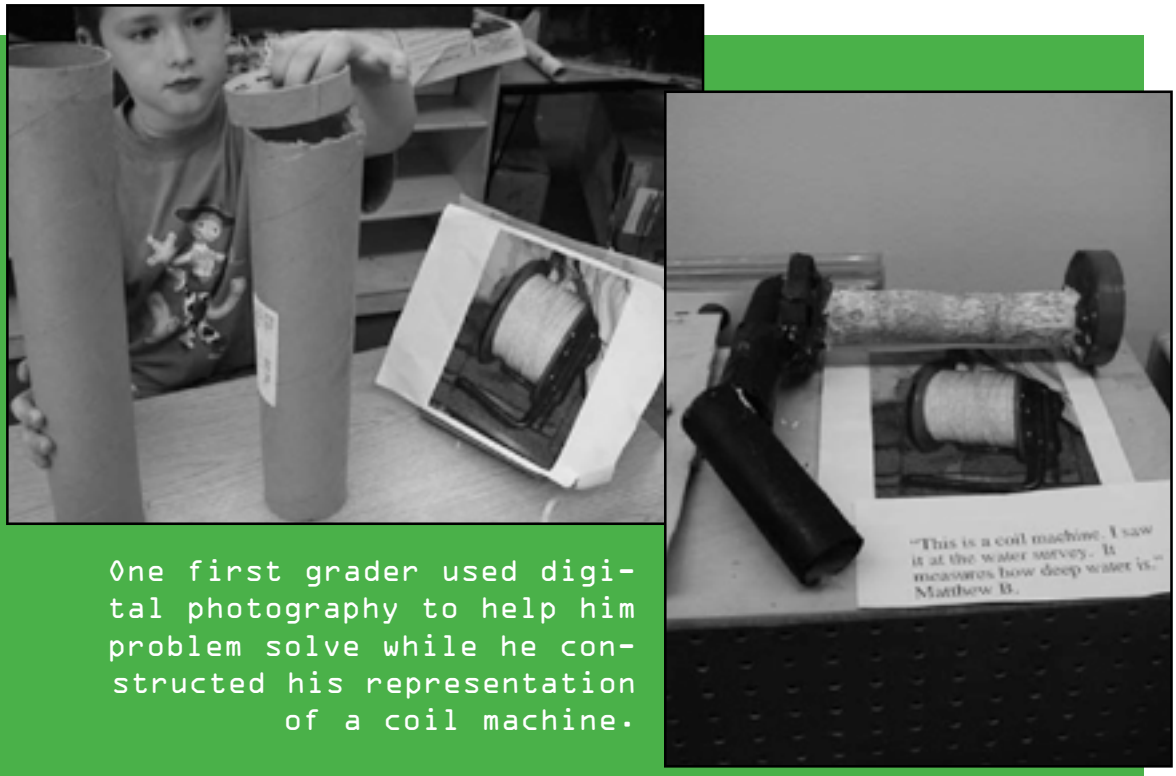
For the last 3 years, we have been exploring, inventing, and experimenting with ways to use technology to engage young children in creative and critical thinking. Technology has exploded in our classrooms, and students have not been the only benefactors. Technology has significantly impacted our teaching, as well. It has also influenced our communication with parents and enriched the ways we view our total school environment. To understand the broad context in which we use technology, it is important to gain a glimpse of our program.

University Primary School (UPS) is an early childhood (ages 3–6) gifted program affiliated with the Department of Special Education at the University of Illinois. Although the children are not tested before entering the program, parents are required to visit to determine if the learning environment is a good match for their child. At University Primary School, the curriculum incorporates the Project Approach (Katz & Chard, 2000), which consists of three phases that guide students through inquiry. Similar to Type III Enrichment (Renzulli, 1977), students pursue in-depth answers to their own questions using firsthand field experiences.

In Phase 1, teachers ascertain what children already know about a particular topic. Students share their experiences and represent their understandings in many ways. By the end of Phase 1, students have discussed similarities and differences in their experiences and have articulated questions about the topic.

In Phase 2, students have opportunities to pursue their own questions, mostly through firsthand experiences. They collect data by observing, experimenting, surveying, interviewing, and going on field studies. Many examples of this data collection are given on the UPS Web site (http://www.ed.uiuc.edu/ups).

In Phase 3, students design ways to share their findings with appropriate audiences. This approach encourages long-term inquiry and enhances the understanding students gain from in-depth studies. It increases opportunities for students to pursue questions of their own interests and gives them multiple perspectives to evaluate critically what they are learning. When students engage in project investiga-



One first grader used digital photography to help him problem solve while he constructed his representation of a coil machine.

tions, they become researchers and follow standard methods of inquiry. Technology is particularly useful within the structure of our environment and curricular framework.

Teachers work with individuals or small groups of children to facilitate their project investigations, to give additional practice or challenges in content areas, or to provide firsthand or secondary resources to help children accomplish their own goals. In the K/1 classroom, there is also time for large- and small-group instruction in language arts and mathematics. A unique feature of the program is the hour-long project/activity time that allows students to move freely among their predetermined choices.

Students' Everyday Use of Technology

On any given day, a visitor might see 3- or 4-year-olds scanning their artwork to upload to their own Web pages, 5- or 6-year-olds creating PowerPoint presentations, peer mentors teaching each other how to use Kidspiration, or students taking pictures of their own products with a digital camera. In our classrooms, children turn to their peer mentors in times of need, rather than the teacher. The teacher might hear, "Where's Sam? Where's Sam? I need him to show me again how to print." One might see Nicole, a first grader, composing a food riddle using Simple Text. She may print it and give it to a friend to guess what food she has described. Alice, a 5-year-old, may be taking digital pictures of the classroom in action as part of a photojournal she is creating with the teacher. The software iPhoto allows her to view her pictures, select her favorites, and write text under them for a storybook.

During project/activity time, the scenarios below are typical.

Kyle, a kindergartner, is on the computer showing friends how he made a food web using Kidspiration:

Kyle: Hey, guys look. I put a cow picture in the middle of the web and a milk picture and then a cheese.
Abby: Ooh! How did you get that blue background?
Kyle: It's easy, I'll show you.
Abby: Can I try?
Kyle: Yeah. Just let me save and print first.

At another computer station in a quiet corner, Carl, a kindergartner, returns to his innovation of "The Old Lady Who Swallowed a Fly." He worked several days on his story entitled "The Old Lady Who Swallowed a Bee." Simple Text allowed him to express himself without the fine motor demands of letter formation. He prints his story and hurries to share his most

recent draft with the teacher. "I'm almost done," he says. "Tomorrow I'll type in about the tiger."

The use of the term *technology* at UPS mostly means use of computers, digital photographs, and digital videocameras (see Table 1). Computers are tools that our students used every day, just as adults might use them. The most frequent use of the computers for the K/1 children is for word processing. Although the teachers' computers have Microsoft Office on them, the children used Simple Text because it is on every machine. Other departments on campus donated classroom computers to us when they upgraded their equipment, and we competed for grants to support our professional development and hardware. Although we have a limited budget for technology, we have developed a "technology rich environment." Approximately 10 to 12 machines in the K/1 classroom eliminate the need for competition to use them.

We have a child-friendly attitude about using equipment. Students handle digital cameras and often have choices about whether or not they want to use technology with their individual or group projects. With this everyday use of technology, students gain valuable computer literacy skills such as how to open, save, quit, and print documents. They also learn how to e-mail, take digital photographs, scan their work samples, and do simple word processing. The integration of technology into the total environment allows them to become familiar with different software programs such as Simple Text, iPhoto, PowerPoint, Photoshop, and Kidpix.

Table 1
Ways Young Gifted Children May Use Technology in the Classroom

Application	Possible Software
Word Processing	Microsoft Word Simple Text
E-mail	Eudora
Educational Games	Gizmos and Gadgets Math Blaster Reader Rabbit Math Storm Treasure Cove Around the World in 80 Days Oregon Trail
Creative Production	PowerPoint Kid Pix Kidspiration Web pages
Information Retrieval	Netscape Internet Explorer

Integrating Technology Into Independent Studies and Literacy

During project/activity time, students with adult guidance and supervision search the Internet to pursue answers to questions in their own interest areas. Students explore biographies (e.g., Wyatt Earp), ways to make things (e.g., hand lotion, paper, perfume), and other topics that are not easily studied through firsthand investigation (e.g., wild animals, the rain forest, the pyramids, ancient Greece). Sometimes, teachers find challenging enrichment activities in the content areas. In one instance, for an advanced math student, the teacher presented a Web site (http://www.mathbrain.com) that gave several different levels for calculations. Web sites of museums are particularly helpful for teachers and students (e.g., http://www.msichicago.org). The Web sites we have introduced to children are too numerous to list here. However, we have bookmarked those that are most useful to both teachers and students so that they can easily return to them.

Technology strengthens literacy instruction. Students choose to write stories on the computer or by hand. Students enhance their writing because they are not concentrating on how to write the letters, but on the flow of ideas. Small-group literacy instruction includes activities related to project work. Students have authentic reasons to read, write, and share. They write memory stories, questions, reports, predictions, and findings. The editing process became easier because they do not have to erase physically, nor tear their papers to correct their mistakes. Also, creative stories stay on the computer, allowing students to elaborate on

them in repeated sessions. Students also collaborate on their writing. They print multiple copies of play scripts or joint reports so that all of the children involved can read them at once.

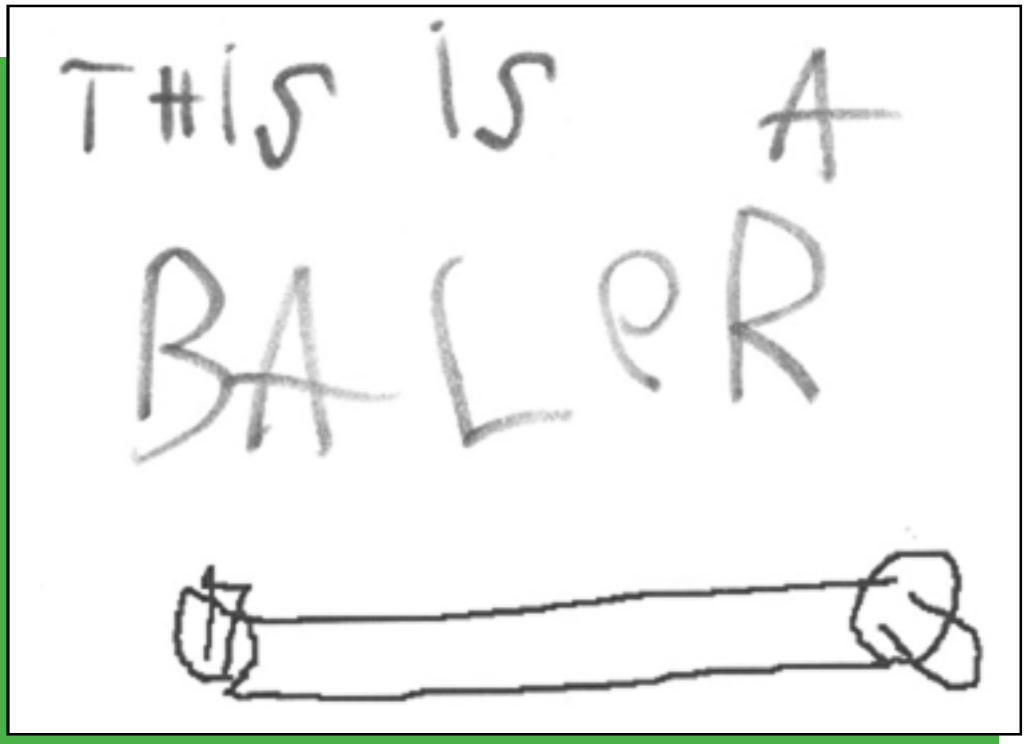


Figure 1. Representation of the baler using Kid Pix

Use of Technology to Support Project Investigations

In Phase 1, students shared memories of their experiences related to a chosen topic. This often included stories typed using Simple Text, computer graphic drawings using Kidpix, and concept webs using Kidspiration. Teachers used PowerPoint or Inspiration to create topic webs, digital photographs to share memory experiences, and typed documentation of their shared experiences.

In Phase 2, our students, armed with digital cameras and videocameras, ventured into the community to take photographs and videos to enhance their data collection. Digital videos helped students remember, reflect upon, and represent more accurately through drawings or constructions what they saw or learned. When our students studied "Who Measures What in Our Neighborhood," they discovered that scientists at the Water Survey used a coil machine to measure water. Oftentimes, students used Kid Pix to create representations of what they observed. Thus, examining the digital data, students expanded their opportunities for critical and creative thinking. Figure 1 shows a student's Kid Pix drawing of a baler that she learned about on the same trip to the Water Survey. Experts presented advanced vocabulary and new concepts that could have been missed if students did not have additional opportunities to review them on video.

In Phase 3 of the project investigation, students and teachers planned a sharing event. Technology maximized the opportunities for students to highlight what they learned with others. For example, students incubated eggs and hatched chickens as part of their measurement project. Figure 2 shows a concept web using Kidspiration developed by a 6-year-old. The web demonstrated to the teacher that the student recalled many details about the incubation process. The student learned that chickens lay eggs; eggs take 21–22 days to hatch; the eggs do not like to get bumped; and people can use eggs in many ways (cooking, eating, and raising chicks). The student noted that it is necessary to have both a rooster and a chicken to get eggs. The teacher inferred that the student understood the difference between fertilized and unfertilized eggs, but went back to further clarify what this student understood. This process of concept mapping allowed the teacher to revisit understandings and ask the child for clarification. Before the project, none of these kindergarten or first-grade students knew the length of incubation, the environment necessary for incubation, or the difference between fertilized and unfertilized eggs.

Students also created PowerPoint presentations to reflect upon their own learning experiences. Some students shared their presentations with their parents at a culminating open house. When students made visible what they learned, teachers had the opportunity to assess the students' level of understanding and growth.

The technology explosion in our classrooms not only involved the children, but it greatly influenced and impacted our teaching.

Impact on Teaching

Based on our experiences, we found many advantages to using technology in our early childhood classrooms. We more readily accessed resources and information to facilitate learning. We increased our use of tools for documenting students' experiences, which enhanced the assessment and evaluation of student progress and individual portfolios. Technology also helped to make students' learning and thinking more visible.

Teachers Access Resources and Information to Facilitate Learning

Teachers at UPS used computers to increase their own knowledge about topics, as well as to search for resources for instructional activities to present to students. For example, one teacher wanted to find a picture of Winslow Homer's art exemplar *The Schoolhouse* to demonstrate how artists represented buildings when the students studied "The Building Where Our School Is." While investigating the project entitled "What Moves Around Our School," another teacher consulted a Web site to better understand a student's question, "How do cars move?" In addition to searching for art and science information, teachers browse the Internet for background information on the topics students are investigating, as well as Web sites that may give them additional resources.

Documenting Students' Experiences

The importance of documentation to the early childhood environment is well articulated (Helm, Beneke, & Steinheimer, 1998, 2003; Helm & Katz, 2001; Katz & Chard, 2000). Documentation enhances children's learning by allowing them to revisit and elaborate upon their ideas and products. It also demonstrates to children how important their ideas are to teachers and other students. Documentation is an ongoing assessment process that reveals progress and misconceptions. It guides teachers' planning and differentiation of instruction. Another purpose of documentation is to tell the story of project investigations. It allows parents to appreciate and participate in their children's learning experiences.

At UPS, we focus on documentation for individual portfolios and for writing and disseminating the project narratives. Technology provides the tools for documenting students' experiences and for collecting student products. For example, in their individual portfolios, we include digital photographs of block and LEGO constructions, scanned pictures of artwork, audiotapes of musical expressions, and transcripts of conversations.

Technology strengthens assessment and evaluation by allowing visualization and review of student products. Students use PowerPoint to

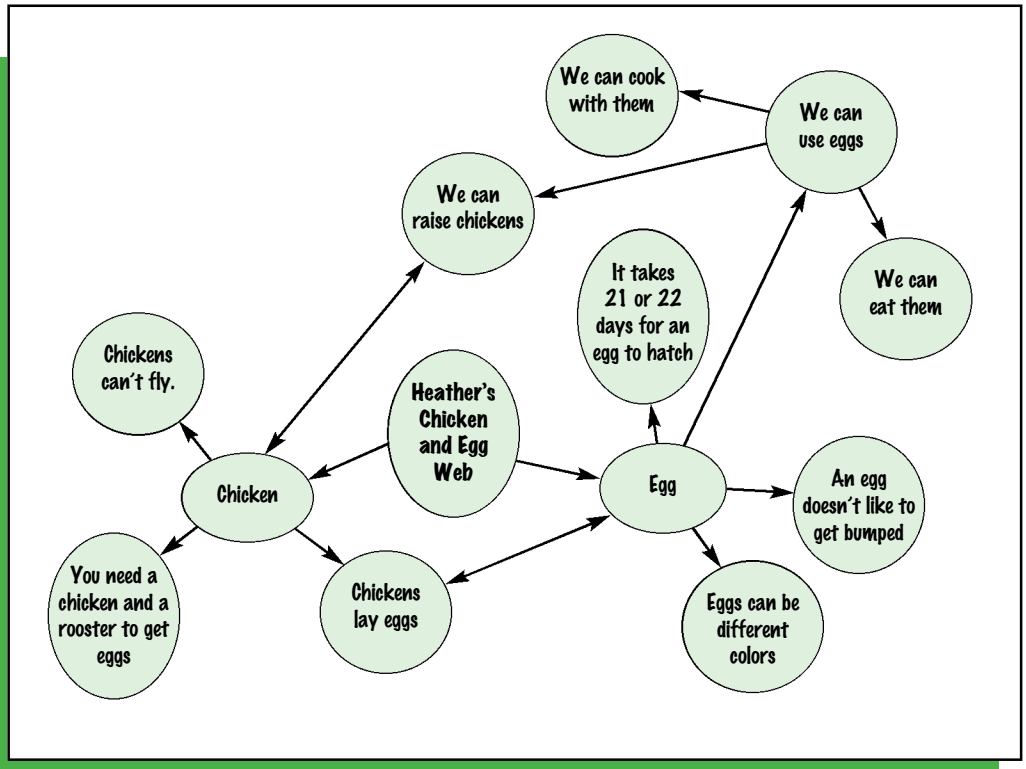


Figure 2. Use of Kidspiration to web ideas

reflect upon their learning (Wang, Kedem, & Hertzog, 2004). This activity engages them in reflective, critical and evaluative thinking and allows them to share their perspectives of the project study with others. Teachers see representations of misconceptions and plan lessons to clarify, probe, and address understandings. For example, Donna reported in her PowerPoint presentation, "In the ceramics studio, they use a kiln and a hanger to measure the pots." The teachers realized that she had learned new words, but did not fully understand their meaning. In a group discussion following the field trip, the teacher asked other students about what they saw at the ceramics studio. The children reported that they saw the kiln and the hanger, but that the caliper tool measured the pots. Another student understood the magnitude of measurement in nearly every field of study, and he expressed this in his PowerPoint presentation (see Figure 3.) The PowerPoint presentations were examples of products that facilitated day-to-day instructional decision making (see the student PowerPoint gallery at http://www.ed.uiuc.edu/ups/curriculum2002/measure/pptgallery.shtml).

Teachers used word processing to type project narratives, observations, and anecdotal notes. They displayed digital photographs of students engaged in all phases of the project. Using software such as iPhoto, iMovie, or PowerPoint, teachers documented field studies, visiting experts, or the process of creating representations to share with a wider audience (e.g., visitors to the classroom, families). Teachers wrote narratives to keep records of projects, aligning project work with state goals and standards. These narratives can be accessed through the UPS home page (http://www.ed.uiuc.edu/ups).

Enhancing Parent Involvement and Communication

As the use of technology steadily increases in the early childhood classrooms, parents have become more involved in the learning process. Parent volunteers play an integral role in the documentation of project activities, often typing students' responses to webbing, questionnaires, or stories.

Teachers use technology in a variety of ways to enhance communication with parents. Dissemination of children's learning experiences in a timely manner has become possible. The following list describes some of the ways technology has been used to facilitate parent involvement.

- Teachers made a slide show of the digital photographs that were taken each day. The next morning, parents viewed the slide show on the computer's screen saver.
- Students created Web pages that parents could view from their own home.
- The annual art exhibition was burned on a CD for parents to purchase and take home so that they could revisit and appreciate the work of all of the children in the school.
- Student plays were digitally recorded and transferred to iMovie.
- Students created photojournals and PowerPoint presentations that teachers burned on CDs for parents.
- Teachers e-mailed attachments of student-created PowerPoint presentations to parents.

We have also embraced parent participation in our technology explosion. Parents can help children be creative and productive at home in the following ways:

1. Encourage children to use word-processing software to write stories, letters, or thank-you notes.
2. Type dictations of children's stories to accompany drawings.
3. Scan children's artwork to save (using minimal storage space).
4. Take digital photographs of children's creative products.
5. Use iPhoto to make memory books.
6. Search the Internet with their child to answer his or her research questions.
7. Help children use graphic design programs such as Kidpix, PowerPoint, and Kidspiration to illustrate stories or make posters or drawings.

The Future of Technology in Our Classrooms

Because we as teachers and parents are digital immigrants, our technology literacy is still emerging. It is difficult to keep pace with new advances. Our staff seeks new and innovative ways to use technology in our classrooms, and we would like to develop better systems and routines for data management. Some of our ideas include:

- electronic individual student portfolios;
- computer files that house classroom photographs related to project narratives;
- designated time and personnel to manage and organize digital photo files; and
- use of parent volunteers in the classroom to create and print out thumbnail images of all of the digital photographs.

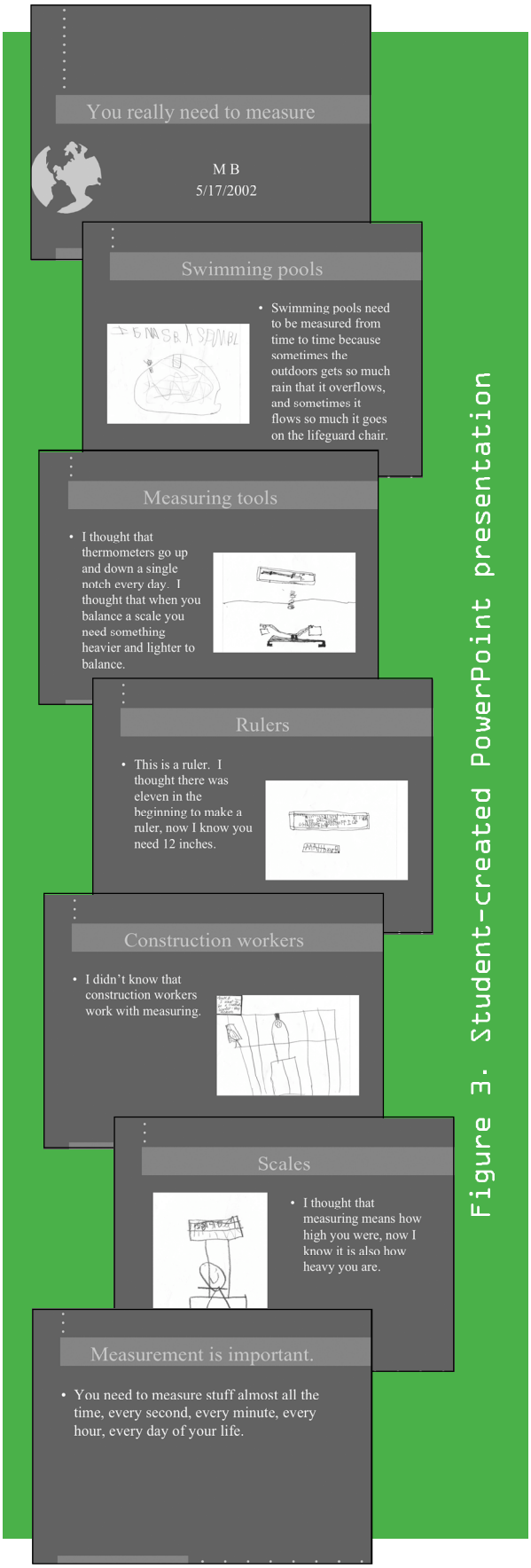


Figure 3. Student-created PowerPoint presentation

With accurate digital storage systems, we could create richer and more comprehensive individual portfolios and enhance the documentation of class activities.

The market for software for children is expanding rapidly. An ongoing goal is to keep up with new kid-friendly programs that engage students in critical and creative thinking. Creative production software, or "Mindtools," such as iPhoto, iMovie, or PowerPoint, may have more kid-friendly versions in the future. We want to learn more about programs that assist with data management.

Not only are choices for software expanding, but the number and varieties of hardware are also exploding while prices continue to go down. We expect that we will soon be able to purchase at least one camera for children to use in each classroom, and we await the day that color printers reduce in cost to be affordable for classroom daily use. In addition, we have just begun to discover equipment that interfaces with our computers to bring exciting learning experiences to the children (e.g., Digital Blue microscope).

Although there are many advantages, using technology presents us with challenges as well. We have evaluated classroom priorities and made choices about what is important for our students to learn and do. We questioned how much time should be devoted to technology skills and what goals would be best accomplished using technology. Managing digital data on the computer has been one of the most time-consuming tasks.

Summary

At University Primary School, the use of technology as Mindtools has been a particularly good match for channeling students' creativity and critical thinking. Students use technology individually and collaboratively to produce reflections of their own learning and representations of their thinking. They enjoy becoming technology-literate. In addition, technology has enhanced the differentiation of the curriculum by facilitating open-ended activities and creative production such as writing, drawing, photojournaling, bookmaking, and webbing. Technology has supported students in moving from concrete experiences to abstract concepts. Just like adults, 3- to 7-year-olds use technology to research answers to their own questions and produce representations of their findings. Our students have gone beyond gaming and consuming. They have grown socially, emotionally, and cognitively as they used technology to create, collaborate, and problem solve in order to express their ideas.

Guided by curriculum standards, teachers at UPS decide what their students should learn and choose from a variety of teaching strategies to help them reach their goals. Technology

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applications are among the many tools offered to children for creative, meaningful, and challenging learning experiences. GCT

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