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Teaching and Learning when No One Is Expert: Children and Parents Explore Technology

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Abstract

Within the field of early childhood education, there is a strong tradition of integrated, emergent, and arts-oriented curriculum that must now respond to a growing and competing emphasis on literacy-based experiences. Considerably less priority (or teacher expertise) has been or currently is demonstrated in the areas of science, math, engineering, and technology (SMET), with math a distant second place to the role of literacy in the curriculum. Supporting teacher resistance to including science, engineering, or technology is the growing body of research on children's learning that makes clear that children learn best when academic domains are integrated within the context of personally meaningful experiences that build upon their own prior knowledge and current interests. For these reasons, it is essential that teachers become better prepared to apply and integrate new technology, not only in the service of teaching math and science but also the bigger goals of helping children learn and develop socially, emotionally, and intellectually. This article highlights experiences and understandings gained from a pilot workshop within Project Inter-Actions—a workshop series during which parents and children learned together about new robotics technologies; played with Legos, computers, and art materials; and built projects that reflected their own cultural practices and family heritage. The discussion considers the potentials of technology to support children's exploration of family values, cultural practices, and religious heritage; explores the complementary nature of two contemporary theories of cognition—constructionism and social constructivism; and revisits prevailing assumptions about developmentally appropriate practices as they inform early childhood education.

Introduction

> *Daughter (5 years old):* I am making a planter. We didn't get the other arm on yet. It's going to plant flowers. Dad, turn it on. It will put flowers in the hole, and then it will have to water them.
>
> *Father:* How can we get this arm to lift it once? Maybe we will program it like that.
>
> *Daughter:* It's ok, let's do it over and over again. I want it to lift for 10 seconds and then drop. You know… that clock button.
>
> Father and daughter work at the computer.
>
> *Daughter:* The left hand is moving now! Look! Look!

This dialogue between a young child and her father captures the collaborative and dynamic nature of a learning experience for parents and young children during a robotics technology workshop organized as part of an ongoing Project Inter-Actions at a northeastern university. In this article, we draw upon experiences and understandings gained from a pilot workshop within Project Inter-Actions to (1) illustrate the potentials of technology to support children's exploration of family values, cultural practices, and religious heritage; (2) highlight the complementary nature of two contemporary theories of cognition—constructionism (Papert, 1980) and social constructivism (e.g., Rogoff, 1990); and (3) revisit prevailing assumptions about developmentally appropriate practices as they inform early childhood education. We begin by sharing a description of the workshop, during which parents and children learned together about new robotics technologies; played with Legos, computers, and art materials; and built projects that reflected their own cultural practices and family heritage. We then consider the ways in which this experience illustrates contemporary theoretical interpretations of children's learning. Finally, we consider the notion of developmentally appropriate practice and how this project provokes us to think about this guiding framework in new ways. We conclude with implications for educational theory and practice and pose questions for further exploration.

Project Inter-Actions

Project Inter-Actions was born from the desire to provide young children with pleasurable and integrated experiences in science, math, engineering, and technology education (hereafter referred to by the acronym SMET) while engaging them in exploration of their own cultural heritage. There were practical as well as philosophical and pedagogical reasons for this initiative. In December 2000, Massachusetts became the first state in the nation to include engineering as part of its K-12 curriculum framework. The resulting statewide curriculum framework includes both technology and engineering for public schools. Within the field of early childhood education, where there is a strong tradition of integrated, emergent, and arts-oriented curriculum, there is growing and competing emphasis on literacy-based experiences with considerably less priority (or teacher expertise) in the areas of SMET (New, 1999c). With the exception of the teaching of mathematics, teachers of young children have resisted the additive approach to curriculum expansion, with the common complaint that “there just aren't enough hours in the day.” Supporting teacher resistance to creating new segments of the day dedicated to science, engineering, or technology is the growing body of research on children's learning that makes clear that children learn best when academic domains are integrated within the context of personally meaningful experiences that build upon their own prior knowledge and current interests (New, 1999a, 1999b). For these reasons, it is essential that teachers become better prepared to apply and integrate new technology, not only in the service of teaching math and science, but also to reach the bigger goal of helping children learn and develop socially, emotionally, and intellectually. Project Inter-Actions was designed to address this goal.

Project Inter-Actions, developed and implemented by the first author (Bers, 2004; Bers & Boudreau, in press), creates conditions that make it possible to examine the many interactions that can take place when parents and young children work together in a technology-rich learning environment to explore and then represent various aspects of the family's cultural heritage. The project's name stems from the different types of interactions considered throughout the project: (1) interactions between adults and children learning together; (2) the dynamics of jointly exploring something that is new for both, such as robotic technology, and something that they are each immersed in, such as their own cultural background; (3) interactions between abstract programming concepts and concrete building blocks as a new way of thinking about “hands-on” learning; (4) interactions between conceptions of what is developmentally appropriate and what children are actually capable of doing with technology at such an early age; and (5) interactions among technology, art, and culture—distinct areas of the curriculum that computers have the potential to integrate.

The specifics of this project as they relate to SMET include exposing children to new technologies, rich enough to allow them to engage in the design, programming, and building of a personally meaningful project—in this case, a robotic artifact that can move and react to stimulus in the world. The technology of choice during Project Inter-Actions is Lego Mindstorms, a commercially available robotics invention system inspired by the MIT Media Lab's programmable brick (Martin, Mikhak, Resnick, Silverman, & Berg, 2000). The toolkit enables children to work with a material manipulative with which they are already familiar, such as Lego blocks, and enables them to augment its capabilities with computation through the graphical programming language of ROBOLAB (Kearns, Rogers, Barsosky, Portsmore, & Rogers, 2001). The humanities component of this project is achieved by setting up an environment in which children and parents can explore books, stories, and symbols from their respective cultural and religious traditions and can engage in conversations about their individual and shared meanings.

A Little History

Project Inter-Actions originated from previous work aimed at integrating learning about values and identity with learning about robotics and technology. This earlier project, dubbed Con-science, took place at Arlene Fern Jewish Community School in Buenos Aires, Argentina, with third- and fourth-graders, their parents, and teachers (Bers & Urrea, 2000). This school was an ideal setting because it is a value-centered learning environment that emphasizes educating not only the children but also the family and the community.

Project Con-science was designed to take place during the Jewish High Holidays, a period of 10 days in which the community gathers to celebrate the Jewish New Year and the Day of Atonement. As part of the Con-science project, families made technological creative prayers and shared them with other members of the community at the synagogue during an open house before the traditional prayers started. Parents and children worked together, using the technology to explore their values and identity in very different ways. Parent-child teams collaborated to:

- *Represent concrete symbols*. For example, a Star of David that turned like the wheel of life, had flashing lights resembling candles welcoming the New Year, and reproduced the sound of the "shofar" to awaken people for reflection and atonement.
- *Represent abstract values such as "teshuvah" (i.e., reparation) and forgiving.* For example, a young girl and her dad created a puppet theater. The theater had a curtain that opened to show the performance of two Lego dolls hugging after a fight.
- *Evoke reflection and conversation about the meaning of values.* For example, one group chose the value "giving and receiving" and explored the similarities and differences between both concepts. They built a robotic doll with art materials and two big yellow hands. A light sensor activated the hands so one gave out presents and the other received something back.

Project Con-science in Argentina has been in operation for the past four years as a parent-child workshop with some involvement from teachers as well as support from the principal and the synagogue, but it is run primarily by dedicated parents. The success of this experience strongly inspired Project Inter-Actions. Potentially significant differences between the two projects are the age and developmental stages of the participants and the range of cultural and religious backgrounds in the U.S. sample. Con-science involved third- and fourth-graders and took place in a setting that is explicitly linked to a single (Jewish) tradition, whereas Project Inter-Actions involved younger children representing a wide range of family traditions and religious backgrounds. Although these differences added extra challenge to the task, they also provided additional opportunities to explore the potentials for developing integrated SMET and humanities-focused educational programs for diverse populations of children.

Constructionism as the Educational Philosophy for Using Technology

The educational theory motivating the work described in this article is based on a constructionist philosophy that asserts that both children and adults learn better when they are engaged in designing and building their own personally meaningful artifacts and then sharing them with others in a community (Papert, 1980). Constructionism has its roots in Piaget's theory of constructivism. However, whereas Piaget's theory was developed to explain how knowledge is constructed in our heads, Papert's theory pays particular attention to the role of constructions in the world as a support for those in the head. Papert proposes computers as especially powerful tools with which to create projects and reflect mental images.

Constructionism has two fundamental ideas that inform educational practice and our work in the project described here:

- Powerful educational technologies can engage children in design-based activities that are epistemologically relevant, personally meaningful, and have resulting products that can be shared with a community.
- Manipulative objects that have computational power, such as the Lego Mindstorms construction kit used in Project Inter-Actions, are especially valuable for supporting the development of concrete ways of thinking and learning about abstract phenomena (Bers, Ponte, Juelich, Viera, & Schenker, 2002).

Having established the rationale for the project, we turn now to a description of the children and families who participated, followed by a depiction of their experiences as they engaged in this joint exploration of technology and family traditions.

Project Inter-Actions—The Project and the Process

Ten families of 4- and 5-year-old children attending one of two campus early childhood facilities were recruited through flyers distributed by program directors and classroom teachers. (One facility was a full-day educational day care center, and one was a more traditional laboratory school with a variety of options ranging from a full-day kindergarten and mixed-age grades 1-2 classroom to preschool classrooms that meet two or three days per week.) The 10 families represented a range of cultural and religious backgrounds, including Jewish, Christian, Muslim, Indian American, European, Chinese, and Caucasian. The free workshop consisted of five weekend meetings of approximately two hours and a half each. There was also a final open house so that children and families could share their projects and the learning process with the school community. Families had the option to visit the computer lab during other times of the week, where they could receive direct instruction from the project staff. Families were also encouraged to take home the Lego Mindstorms kit so they could explore it on their own time. During the workshop, parents and children learned together about new robotics technologies; played with Legos, computers, and art materials; and built projects that reflected their own cultures.

We planned and conducted the workshop sessions based on principles of full immersion, such that families were involved in all aspects of the project—they chose the culture to explore, decided on what materials to use, managed the resources and time frame, resolved the technological challenges (both in terms of programming and mechanics), created narratives around the final project that were posted on a Web site documenting the experience, and presented their final projects during an open house.

The goal of these workshops was not to have children and parents master the same programming and building skills; rather, the goal was to embed them in a technology-rich environment with diverse expertise and interests. The hope was that in such an environment they would form a community of learning (in which everyone was doing things with the technology) that helped each participant increase his or her technological fluency. Reflecting these broad goals, each of the five sessions of the workshop had a specific objective in mind. The goal of the first session was to help families learn both the building and the programming aspects of the technology. The second session was designed to teach more advanced programming techniques. The third session focused on concepts of culture, and families were asked to begin thinking about final projects. The fourth session was dedicated to work on their own projects. At the fifth session, each family presented the final project to the group in preparation for the open house. Although the sessions were intended to be informal, some structure was required in order to accomplish our goals. Each session included some time in which (1) we gave direct instructions about what the parent-child teams were to do, (2) families worked independently on their projects, and (3) families presented their projects informally to the group and received feedback from their peers. The following features further supported these five sessions:

- *Materials/Set-up.* We gave each family a computer and a Lego kit containing the essential components needed to build a robotic project (explained further in the technology section). On one table, we provided various art materials, such as construction paper, markers, colored pencils, crayons, felt, buttons, glue, and straws. These materials were to be used either in the planning stages or on their actual projects. On another table were bins of Legos—for example, beams, plates, bricks, wheels, and connectors. The placement allowed the families to take whichever materials they desired for maximum creativity.
- *Teaching.* Each teaching or direct instruction section was brief (approximately 15 minutes), and we always used a simple example. For example, when learning about motors, a windmill was used to show how the blades moved faster if the speed of the motor was increased. The teaching was aimed at the children, although the more advanced concepts were also explained to parents upon request. During the third session, when discussion of the final project began, we had an open dialogue with the families about their ideas of culture. We showed them examples of cultural symbols and objects. We also had relevant children's books. Finally, a sample robotic project was shown as a concrete model.
- *Building.* The families devoted the majority of the time during the sessions to the actual construction of their projects. During the first two sessions, they were given open-ended mini-projects, called challenges. The project coordinators would walk around the room, providing help when necessary. When working with the families on a one-on-one basis, we made sure to not just "do it for them," instead we would walk families through the programming process and guide them with pointed questions rather than provide them with answers.
- *Technology Circle.* At the end of each session, everyone would gather in a circle for informal presentations. They would show their project, regardless of the stage that it was in, and talk about what they were making, what inspired them, what problems they encountered, etc. Other families could ask questions or provide help from their own experiences.
- *Documentation.* Four means of documentation were used to "make learning visible" (Project Zero & Reggio Children, 2001) to the project directors as well as the participants: (1) digital photographs, (2) digital video, (3) observation records, and (4) reflections. One person outside of the project, a teacher who was familiar with some of the children, took notes during and following observation throughout each workshop. She also conducted informal interviews with the families and transcribed interesting conversations that occurred. Families also documented their projects on their own by taking digital pictures and then writing about their final project and experiences with the workshop on the project Web site: http://www.ase.tufts.edu/devtech/Project_Inter-Actions/.

Promising Possibilities from Project Inter-Actions

To evaluate this first multicultural exploration with Project Inter-Actions, we utilized informal interviews with participants; observations of interpersonal relations, uses of the new technology, and changes over time in the families' ways of approaching a problem and dealing with conflicting issues; final projects; and comments written on the Web site. We also received feedback from the directors of the schools and some of the teachers. Before the start of the first workshop, each parent was asked to complete a pre-questionnaire so we could learn about their previous experience with technology, their religious and cultural beliefs, and their perceptions about their interaction styles with their children. The children were asked similar questions orally. As a result of this multiple source approach to feedback and evaluation, we learned a good deal about children and families, teaching and technology—some of which confirmed prior hypotheses; some of which surprised and challenged us. The following lessons are in the form of preliminary results drawn primarily from the pre-questionnaires and the observations of family interactions during the course of the workshop sessions.

Lesson 1: The Value-Added Potential of Technology That Makes Robots

The potential of using objects to think with and learn about SMET has a long-standing tradition in early childhood education. During the mid- and late-1800s, Fröbel and later Montessori designed a number of "manipulatives" or "gifts" to help children develop deeper understandings of mathematical concepts such as number, size, and shape (Brosterman, 1997). Today, early childhood settings are populated with Cuisenaire rods, pattern blocks, and a variety of other manipulatives carefully designed to help children construct mathematical understandings as they build and experiment. More recently, but in the same spirit, “digital manipulatives” (such as programmable building bricks and communicating beads) have been created to expand the range of concepts that children can explore (Resnick, 1998).

It is within this “hands-on” tradition that robotics was seen as presenting a wonderful opportunity to introduce children to the world of technology. Not only can children design and build interactive artifacts using materials from the world of engineering, such as gears, motors, and sensors; but in this particular project, they are also encouraged to integrate art materials and everyday objects to make their projects aesthetically pleasant and personally meaningful.

This hypothesized value of robotics was confirmed repeatedly over the course of this workshop. The Lego Mindstorms robotics construction kit that we used in the workshop is composed of a tiny computer embedded in a specialized Lego brick, called RCX, that can take data from the environment through its sensors, process information, power motors, and control light sources. This microcomputer can be programmed with a graphical programming language, ROBOLAB, which allows users to drag and drop icons that represent commands to produce behaviors for a robot (see Figure 1). The program in the computer is downloaded to the RCX brick via infrared.

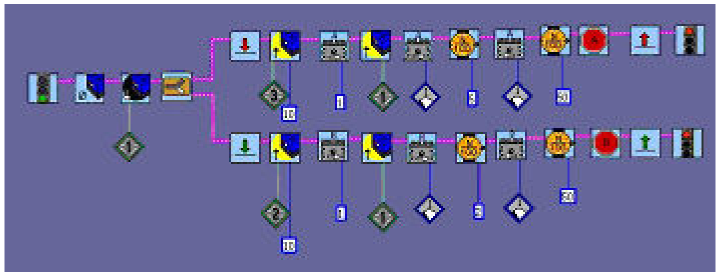

Figure 1. An example of a ROBOLAB program.

All of the participating families were successful in terms of building a robot that would move, play music, or react to the light or the touch sensor. The final projects displayed diverse levels of complexity based on the previous experience of the child and the participating adult, as well as the developmental stage of the child (the youngest children were having problems manipulating the mouse). However, during the workshop, all children and parents learned how to engage in the engineering design process, how to make basic programming structures to program their robots and to debug their programs to make them work, and how to use different strategies for solving problems.

Lesson 2: Adults and Children as Learners when Families Work Together

Children and their participating family members not only learned about technology as a result of their participation in this project—they also learned about each other's understandings of their family's particular cultural and religious heritage. As previously described, each family created a project that they felt symbolized an aspect of their culture. The projects represented a range of ideas and were given special titles by the families. They also served as a catalyst for family discussions on topics about which children had previously shown little interest, as revealed in the following vignette:

> *The Cake:* A mother and daughter (5 years old) designed this project. The daughter wanted to make a birthday cake for her aunt who was visiting the week following the end of the workshop. Lights, as candles, were added, and they programmed the RCX to play "Happy Birthday" as well as an Armenian song (see Figure 2). The mother wrote, "As the culture piece, I thought she might like adding some Armenian music to the cake, as music is an aspect of my family's culture she enjoys, and she was planning to perform a dance for my sister's birthday anyway. The song that the cake plays is a children's song called 'dzapig, dzapig,' which means 'clapping, clapping.' It's followed by 'Happy Birthday.'" After the project was done, the mother shared with us that during dinner her daughter asked her dad, "What is a Muslim?" "This is the first time she has taken any interest in culture and understandings of it. The notion of culture in our family is complex, and this project provided us with an opportunity to discuss culture."

Figure 2. A mother-daughter team work together on the decorations for their cake.

These workshops also created conditions in which family members of diverse ages could all participate in a shared project that had personal meaning for each person. One family team that included a mother and her two children was able to work successfully together in negotiating conflicts and diverse interpretations, ultimately building upon each person's knowledge, interest, and capabilities, through the integration of creative art materials and the potentials of the robotic technology:

> *The Easter Rabbit: Bunny and Basket.* This project was created by a mother, daughter (4 years old), and son (7 years old) team. The idea for this project came mostly from the son who was looking forward to the Easter egg hunt. This family created a base with wheels that could go forward. On this base, they built an arm that would rotate upward after a certain length of time in order to pick up an Easter basket that they had constructed out of paper. They then mounted a large paper bunny they had drawn onto the base (see Figure 3). This project is a good example of how families were able to combine technology with art materials.

Figure 3. This family decided to mount a paper drawing that they had made onto a base with wheels.

Although most of the learning encounters ("inter-actions") were positive and affirming, some were not. Different families had different working styles, and parents had varying expectations of what should be happening. It was not always easy for all of the parent-child dyads to become comfortable with each other as they shared new roles as both teachers and learners. Unanticipated was the finding that, in most of the cases, the parents, not the children, had the most difficulties adjusting to this shifting status from expert to novice.

The following dialogue illustrates the usefulness of inviting families to share, but also the challenges of asking parents to publicly acknowledge their novice status. It also illustrates the potential role of the child as expert:

> *Father 1:* My son and I made this car and it turns, but I think that something is wrong with it. You see it's running, but I think I have two motors but that one is not moving.
>
> *Father 2:* That happened to us; you may have the wires messed up.
>
> *Boy 2:* Yeah, look at our car; see what happened with the motors all messed up…. Our wheels were going like this! (Spinning arms in circles.)
>
> *Boy 1:* But wheels are going like this and like this…the wrong way…they both need to go that way. Then it won't break.
>
> *Girl:* Do you need help with your motor?
>
> *Boy:* My dad and I don't know how to do it yet.
>
> *Father:* We have no idea.
>
> *Girl:* I can show you. You need to add this piece to this, and then use the computer to make it go.

Lesson 3: New Ways to Think about Children's Learning through and about Technology: Changing Concepts of Developmentally Appropriate Practices

This study provided ample opportunity to learn about parental views and anxieties regarding the developmental appropriateness (DAP) of children's learning opportunities. The concept of DAP is well known in the field of early childhood and has as a primary principle the notion of age-graded approaches to learning in which children are provided with experiences that correspond to their developmental needs and individual characteristics (Bredekamp, 1987). While the more recent revised interpretation of developmental appropriateness now acknowledges the need to challenge and teach children within their "zone of proximal development," guidelines for developmentally appropriate practices also place increased emphasis on the importance of respecting family values and interpretations of appropriate educational experiences (Bredekamp & Copple, 1997; New, 1993, 1999c). As the following vignette illustrates, this series of workshops challenged parental conceptions of what their children were "ready" for. It was also the case, however, that for most families, the question of "appropriateness" was resolved when it became apparent that children were enjoying and responding constructively to the challenges associated with this project:

> When our family was first accepted for the project, I had a mix of feelings. I looked forward to having structured time to be with my son and expand our abilities in an area we have enjoyed together, building things.… But I had reservations, too, as did my partner. We weren't clear how much time the child would be engaged at the computer and wondered if it was appropriate for someone at this stage of development.

This quote from the father of a 4-year-old participating in the workshop represents the worries that some parents had before the workshop began, and that some parents conveyed at the very first session. As we explained to them that one of our goals as a pilot project was to explore this very same question, families seemed to respond with one of two different approaches. One approach, taken by the father quoted above, was the decision to lower his own expectations and think of this workshop as an introduction to some concepts that would be visited later on by his child as he grew older. Once he began to consider that there were stages in children's learning as well as stages in their development, his worries about developmental appropriateness disappeared, and he and his son seemed to fully benefit from the experience. As he noted during his concluding interview:

> Once in the workshop, it was a very welcoming environment.… The staff was very clear that this was about the process of experimenting with technology with your child, not about accomplishing a fully realized project. Still, I did find the learning experience a little daunting and had some frustrations with mastering it well enough.… I think my son really enjoyed making his own construction paper robot—he was very excited about showing this to his mom. He was also quite proud about doing a little programming.… In summary—I'm glad we did it, even if the robot really doesn't find Matzoh.

This father was able to put his own preconceptions aside and engage in playful experimentation. If anything, the challenge that remained for this father was to accept the fact that his son was able to benefit from an experience in which the adult also experienced the uncertainties associated with a lack of prior knowledge.

Parental anxiety was especially high for those who were unable to be assuaged in their concern about this experience's appropriateness for their young children. One mother in particular was very concerned about her son "not getting it" because it was "too complicated" and not "developmentally appropriate." Meanwhile, the son was probably one of the fastest learners in the workshop, eager to try different things and explore both simple and complex concepts such as gears, computational variables, and forks. Although the mother's concerns were sufficient to cause her to consider quitting after the first session, the son's enthusiasm kept them both involved for the duration of the project. She continued, however, to judge the activity as inappropriate, and, further, she judged her son's learning as inadequate when, for example, his car would break when going fast and he could not successfully program the car's behavior without some assistance from her. In the son's perspective, the workshop was fun, and it was a matter of trying things out until, maybe, one of the strategies would work. The important question of what it means to "get it" as an adult and to "get it" as a young child surfaced in many different facets of the workshop.

Lesson 4: Concepts of Competence when Motivation Is High

Closely linked to the question of developmental appropriateness was the observation that children, sometimes more often than parents, were able to successfully overcome obstacles and frustrations created by purposeful and accidental experiences within the workshop. In our experience, participation in this kind of workshop can be extremely confusing for families the first time because they are dealing with new technology, new building mechanisms, new concepts, and new pedagogical methodologies. As the previous paragraph about parental anxieties suggests, this anxiety is generally the case for adults, but it is not always the case for the children. It has been our experience that children usually approach the learning experience with less nervousness and are not so worried about getting it right. They tend to be more playful and learn little by little, at their own pace, while having a fun exploratory learning experience about technology.

As illustrated in the following vignette on the “Matzoh Robot,” children in this pilot study workshop surprised both teachers and their parents in their resilience and resolve, sometimes in the face of seemingly impossible hurdles, to persist in the construction of projects that went awry. These experiences enhanced parental views of their children as not only capable of working with complex concepts and materials but also able to overcome frustration when the motivation to succeed is sufficiently personal and supported by new skills and understandings:

> *Go-Lem, the Matzoh Robot.* This project was created by a father and son (4 years old), just a few days before Passover. The son began the process by making a large cardboard version of their robot and adding various art materials. This approach allowed them to think through what their final design would look like. The father wrote on the Web site, “It is (or was supposed to be) a matzoh-seeking robot. It goes forward, lights up, and plays the Passover melody "Dayenu" at the push of a button. It is 100% unleavened.” The last day of the workshop, as they were coming into the lab, they slipped in the mud and the final version of the robot, which they had built at home during the week, fell apart and broke into pieces. After overcoming frustration, they quickly built a simpler robot on wheels with a piece of Matzoh glued to its hat (see Figure 4).

Figure 4. Although the first attempt at this project was destroyed in the mud, the father-son team was able to re-create a simpler version, complete with Matzoh!

Conclusion

Results of this pilot study contributed to an increased understanding about the value of robotics in technology education, the usefulness of shared and culturally grounded projects to promote parent-child discourse and mutual understanding, parents' changing interpretations of developmentally appropriate practices, and the powerful potential of engineering to engage children in conceptually challenging experiences. This short study also leads us to new insights as well as questions that we had not previously entertained, which we discuss in the following sections.

The Role of Technology in Changing Family Dynamics

Some in the field of early education have expressed concerns that the growing presence of technology in schools and in homes may serve to inhibit time for conversation and interactions with family members. To the contrary, this project served to support and enhance family interactions as children engaged, with siblings and parents, in a dynamic process of discovery and design that drew upon their shared interests and their combined expertise. Research has also suggested that in spite of changing gender roles in the workforce and the family, actual patterns of parent involvement are not “that different from previous generations.” Indeed, “in spite of a changing societal context,” fathers participate “very little” in child-rearing activities, with mothers more accessible and available to spend time with their children in “parallel and functional activities,” while fathers remain more to engage their children in play activities (McBride & Mills, 1993). In this brief pilot study, in direct responses to the incentive provided by this technology-inspired “problem,” both mothers and fathers spent purposeful time with their children in discussing aspects of their family's cultural and religious heritage and in working together with their children in the design of a technology-enhanced representation of their shared understandings. The educational experiences in this study took full advantage of the affordances provided by the particular technological resources available, such that many of the interactions between parents and children took place *around* rather than *with* the technology. This finding has major implications for research on the expanded potential of technology in classrooms as a tool for learning and as a catalyst for social relations.

Expanded Theoretical Interpretations of the Nature of Expert/Novice Interactions

Much has been made in the contemporary theoretical literature of the role of the more capable peer in promoting children's learning and development (Forman & Cazden, 1985; Rogoff, 1990). Within the context created by Project Inter-Actions, however, family teams often were required to work together when no one was capable of determining the appropriate sequence of steps to follow in accomplishing their shared goals. The eventual success of families in this study is reminiscent of findings in an earlier study that challenged the Vygotskian notion that “cognitive growth requires expert/novice interaction”; in that study, both less advanced and more advanced partners progressed primarily as a function of the quality of interpersonal dynamics. As noted by the researcher, such studies suggest a greater degree of cognitive interdependence than has been previously described, in which “the interaction is of greater importance than the ability of the partners” (Cannella, 1993, p. 441).

As noted previously, a primary goal of Project Inter-Actions was to immerse families in an environment where they could begin to develop technological fluency. We did not expect them to become programmers or engineers; we did not even expect them to understand everything that was said or done at the workshop. Rather, in the same spirit as the apprenticeship model (in which learners at first have legitimate peripheral participation and only later on do they gradually increase their engagement and complexity of participation), Project Inter-Actions provided an environment for both children and adults to participate in a community of learning in which technology and cultural issues were approached hand-in-hand.

There is little question that in the course of these five sessions of Project Inter-Actions, the various members of the family teams took turns supporting the other member, and it was the context and nature of their exchanges that were key to the eventual success or failure of their collaborative engagement. Indeed, in some of the family exchanges, the notion of promoting cognitive change through social conflict, such that “two wrongs make a right,” was in ample evidence (Ames & Murray, 1982). This finding suggests that teams of teachers and children can engage in collaborative inquiry with appropriate technological tools, such that everyone learns how to do something new. Future research might well focus on the patterning of adult learning as it occurs in direct relation to children's new understandings.

When the End Is Also the Means: Technology as a Source of Scaffolding

The term technological fluency was introduced by Papert (1980) in referring to the ability to use and apply technology in a fluent way, effortlessly and smoothly, as one does language. For example, a technologically fluent person can use technology to write a story, make a drawing, model a complex simulation, or program a robotic creature. As with learning a second language, fluency takes time to achieve and requires hard work and motivation. This workshop presented both adults and children with a challenge—and the tools and motivation with which to tackle the unknown. The success with which each family team managed to learn the basic elements of programming their robotics was met not only with joy, but also the enthusiastic desire to build on those initial successes and take on more challenges. The immediate and clear feedback— *it works!*— was also contagious, in that both children and adults were willing and able to offer and accept advice and suggestions for alternative solutions from each other. These are the sorts of learning conditions that would serve teachers and children well in a variety of classroom settings and circumstances and belie the notion that children will become too easily frustrated if given challenges that are beyond their capacity. This finding joins a growing volume of literature that underscores the importance of personal interest and investment in facilitating children's learning of SMET (Clements, 1999; New, 2004; Wright & Shade, 1994). Future research is warranted on the various ways in which children acquire technological fluency and also on quantity and quality of creative problem solving that might be generated as a result of optimal levels of challenge and success.

The Potentials of Parent-Teacher Partnerships in Promoting Children's Learning and Development

As families were immersed in a technology-rich learning environment in which they were actively engaged in a project that they and their children cared about, teachers also had the opportunity to learn through a form of “legitimate peripheral participation”—that is, through their observations of parent-child interactions and children's approaches to educational challenges. The wealth of information made available to teachers about how children learned, and how parents viewed their learning, in this workshop series could serve them well in establishing more respectful and reciprocal home-school relationships. The notion that parents represent valuable sources of support and information regarding children's learning experiences and potentials is not widely recognized by educators (New, Mallory, & Mantovani, 2000). And yet the pride and pleasure taken by parents who had such firsthand experiences with their own children—and the potential uses of the knowledge gained—was fully visible to the teachers of the children in the study, as illustrated in the comments by one mother:

> I am proud of what we made…my children solved the issues we had with our design. I really tried to get them to do the thinking and kept asking them questions. My son is proud of how he was able to program our project. My daughter is very proud of the project because she likes the bunny and how it moves and picks up the basket she made. She grasped some of the technological concepts of the project such as the motor connection, the “wire” connection when programming, and how the program had to be downloaded to the brick.

As these children grow and additional (perhaps longitudinal) studies are conducted, we will have more opportunities to consider the role of such early experiences within a culture of learning about technology in a playful way. Results of this pilot study are informing the design of a controlled study to investigate the relationship between parents and children's learning together about technology in a learning community in which age and expertise are not always linked to each other. In addition, the study will investigate whether this kind of learning environment is more conducive to better learning, not only about technology but about the family's cultural heritage. Additional questions for future study that grew out of this pilot study include the diverse ways in which young children and their families conceptualize family heritage, religious beliefs, and culture. The potential exists to do much more than bridge the gap between technology education and technophobia; the means exist to also bridge the gap between the home and the school, not to mention the sometimes separate worlds of children and adults.

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