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KidPad: A Design Collaboration Between Children, Technologists, and Educators

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ABSTRACT

We established an interdisciplinary, intergenerational collaboration in the fall of 1995, between the University of New Mexico's Computer Science Department, the College of Education, and local Albuquerque elementary school children. The goal of this research was to develop an expressive digital medium with an intuitive zooming interface, to support a learning environment for children. In the process of this collaboration, design methodologies that support a child's role in the development of new technologies were explored. What follows is a summary of our iterative design experience, collaboration, and the results of the research to date.

Keywords

children, design techniques, cooperative design, educational applications, evaluation, participatory design, social issues, Pad++, KidPad.

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THE COLLABORATION

In the fall of 1995, an interdisciplinary, intergenerational collaboration was begun between the University of New Mexico's Computer Science Department, the College of Education, and local Albuquerque elementary school children. The focus of this collaboration was to use emerging new technologies developed by computer science researchers, to create new learning environments for elementary school children. Rather than developing new technologies and then later asking children for their feedback long past the completion of the initial design stages, we chose to establish a collaboration with children at the onset of our research.

Traditionally, researchers have observed children using technology tools, and when appropriate, asked them to take tests using standardized instruments [8, 9, 13, 18]. Such technology evaluations may be well-suited to understanding the impact a specific technology can have on a child's learning, but it can do little to tell researchers what new technologies should be created for the future. While children may not be programmers or engineers, they are experts in what they want and why they want it. We believe that children have a great deal to say about the world they live in and the technologies they use [7]. Therefore, it is critical to find methodologies that support a child's role in the design process. We have begun to combine participant observation techniques with participatory design experiences. In this way, we believe we can better understand what children may do with technology, and what they may want to do with it in the future.

With this in mind, researchers from the College of Education and the Computer Science Department worked for six months with 48 local elementary school children (ages 8-10). Initially, as a way to explore the children's interests, we had them use an existing version of Pad++: software developed by researchers at the University of New Mexico and New York University which replaces windows with a zooming information environment [2]. Instead of double-clicking through piles of folders and icons, the children drew, wrote stories, and zoomed through their information space. While Pad++ was not designed to be a tool for children, researchers saw the possibilities for future changes and developments appropriate for children. Participant observation, video taping, and researcher notes were used to understand the children's technology experience. From these observations, a new set of Pad++ tools (initially called KidPad Local Tools) was developed [3]. Children then worked with these new tools to continue their story-writing experiences.

After a few months, the KidPad child users were asked to describe their own "dream" KidPad environments. The children brainstormed with researchers, drew storyboards, wrote explanations, and presented their work. These concrete design suggestions motivated a new version of KidPad. With this new version, again, researchers worked with children to analyze the potential for future development. In the design briefing that follows, a summary of our iterative design experience, interdisciplinary/intergenerational collaboration, and the results will be discussed.

GOALS FOR APPLICATION DEVELOPMENT

We have focused on three goals in the development of new learning environments for children:

1. To develop integrated learning environments that support visual and verbal literacy. Children like to tell stories; they love to draw. We observed this time and again among the children we worked with in schools. In addition, teachers and parents find it crucial that children learn to express themselves with words and pictures. A new type of literacy is being stressed by educators that asks learners to be literate verbal and visual thinkers [9, 13, 14]. With the advent of multimedia technologies, children and adults must come to make sense of their world in words, pictures, sound, video and more [15, 18].
2. To support learners in constructing their own paths to knowledge. All too often, when a computer application is labeled "educational" verses "a game", it comes to mean "drill and practice" instruction or an interactive textbook. Flashcards which prompt children for the "right" answers are not the only way to create meaningful learning environments [8, 16]. Recently, educational environments for children have focused on more open-ended, tools-oriented environments. These are often called "constructivist" or "constructionist" applications which offer children tools to explore different content areas by constructing their own paths to knowledge [8, 10, 11, 17]. Examples of such environments are Logo (a children's programming language), HyperStudio (a multimedia authoring tool for children), and PageMaker (a desktop publishing tool often used by children).
3. To develop methodologies that offer a better understanding of what children want or need when using new technologies. A majority of the current literature that discusses children's input in the technology development process consists of anecdotal descriptions of how children have offered feedback (e.g., suggestion for button changes, add-on features, etc.). While this type of interaction with children is valuable in short-term technology development, it does not offer possibilities for

generalization and lasting impact on new technologies. If children can be heard before technology has begun to be developed, more profound technology innovations may be possible. For example, at CHI'95, 50 tutorial attendees worked with 25 children in small design groups to prototype new multimedia environments for children. From this experience, the adult participants offered such comments as: "Kids really know what they like..." "The children seemed to be catalysts and sparked ideas I wouldn't have thought of..." "I underestimated the kids..." "I think the children definitely changed the group dynamics and our design..."[8]. At the University of New Mexico we believe it is important to develop methodologies that support collaboration experiences with children as our design partners.

THE USER PROFILE

We anticipate users of our new educational technology environments will be elementary-school-aged children with a wide range of abilities, experience, and age. Children with bilingual needs, simple motor coordination skills, little computer experience, strong writing skills, intuitive visualization abilities, extensive computer experience and more-- are all considered potential KidPad users. This wide range of users was seen in the collaboration begun in the fall of 1995. The 48 local elementary school children that we partnered with were extremely diverse in their skills and backgrounds. These children included participants in basic literacy programs and participants in gifted child programs. Their ethnic backgrounds ranged from Native Americans to recently immigrated Vietnamese, Chinese, and Hispanic children.

THE DESIGN PROCESS

An Interdisciplinary Design Approach

As new technologies take advantage of more forms of media (e.g., sound, animation, video, etc.), professionals with experiences outside of a technical discipline are needed to contribute to the development of these technologies [4, 5, 6, 8]. When we began our collaboration, we looked to work with students, staff, and professors from both the Computer Science Department and College of Education. We believe that both computer scientists and educators can make significant contributions to the development of educational technologies. In working with our child collaborators, we were careful to have both education and computer science researchers experience significant contact hours in the classroom. In this way, there were few questions about the field research that was conducted. Different researchers with different points of view contributed to the data collected.

What we found was that researchers from each discipline were sensitive to different issues, observations, and experiences. For example, educational researchers were more aware of when the children grew bored, excited, or confused with the technology. On the other hand, computer scientists were more sensitive to how the children used the software and quickly saw where new technologies could be developed. Together, researchers developed a knowledge base of information before even one line of new code was generated. Only after two and a half months of collaboration with children, was the beginnings of a new technology environment developed. This made some of the computer scientists nervous. They were much more used to writing code than they were spending their research time with children.

At the onset of our field work in classrooms, there were days when some computer scientists felt unsure of what to look for when working with the classroom children. They felt uncomfortable that they had been thrust into the role of teacher rather than researcher. In those days, it was the educational researchers that were more at home working with the children; developing activities and coaching the students along until they found some proficiency with the technology. But as time went on, confidence grew in many of the computer scientists when it came to working with children. One technique that seemed to put both adults and children at ease was that researchers worked in small groups with students (e.g., one researcher to two or three children). Slowly, both adults and children began to feel more comfortable with the technology and each other. Eventually, children were able to offer design suggestions and point out problems with the software. It was then that the computer scientists took the lead and began to develop the first versions of KidPad. It should be noted however, that even at software design sessions, back at the labs in the university, educational researchers were present and considered to be full partners in the design of the software. This however, did not mean that there was full consensus in what to work on and when. There were times that the educational researchers wanted much more than what was possible with the limited programming resources available. Eventually however, thanks to some insightful discussions, a common understanding was established.

What we found interesting about the development process as a whole, was that each research discipline took turns leading the activities, depending upon the expertise that was needed in the context of the work. However, at no time were researchers from either discipline excluded from the research activities. While there were moments of frustration when research activities were unfamiliar or not clear, we found that an interdisciplinary research partnership can be an exceptionally supportive, creative, and productive experience.

Children As Our Design Partners

Collaborating with children is very different than collaborating with adults. Generally, when a user is brought into the design process, he or she can offer discipline expertise (e.g., in law, medicine, music, etc.). Children are experts at being kids; but exactly what that means is hard to say. They can't offer you a list of the five important things you must include in your technology. Often, children are not that self-aware or verbal about their needs. They must be given opportunities for communication and self-awareness, either through experience with technology or through participatory design exercises that ask them to see possibilities using low-tech prototyping tools.

For example, one design exercise early on asked children to begin brainstorming on paper by using a game board. On one side of the board they selected cards containing a short description of the technology they were to design (e.g., house-building software, letter-writing software, a trip to the New Mexico State Fair) , and on another side of the board they selected the various interface devices they thought they'd use (e.g., keyboard, mouse, joystick, etc.). Lastly they were given a few blank squares to draw their thoughts about the software they were designing. Thanks to this exercise, we saw software "features" we could never have anticipated (e.g., a "window bars" option in the house-building software, because according to one child designer "no one wants to have their house stolen on the computer"). Through this exercise, our child collaborators became more sensitive to the ingredients that they were asked to consider with the real software they used and discussed with adult researchers.

What we found in our collaboration with children was change and growth. We began our work together, as unequal partners. We as adults had to facilitate the children's use of the technology. We had to explain how things worked, and what possibilities they might try. While many of the children had used computers before, none had ever used a zooming software interface. It took some time to get used to, and some time to start asking questions. While we adults were facilitators and advisors, we were also observers. We immediately saw what activities the children enjoyed; we immediately saw what confused them. However, as the children's expertise grew, so too did the number of suggestions and design ideas they offered. Eventually, as their confidence grew we asked directly for design ideas, as opposed to waiting to be told them. We asked the children to develop storyboards of design ideas for the future. By the time the children were done, they had grown into full-fledged design partners. They needed time, experience, self-awareness, and confidence in our design relationship. With adult design partners, time, experience, and self-awareness may not be something necessary to develop; with children it may be critical.

THE DESIGN EVOLUTION OF KIDPAD

The following stages can be seen in the iterative design of KidPad:

The Pad++ Interface Used with Children

Children and researchers began by using the Pad++ software to tell stories. As the children became immersed in this zooming environment, we saw that they LOVED to zoom. When left to their own devices, the children spent hours zooming the Pad++ surface. Their favorite activity was to draw a face, then zoom closer to draw another face inside the eye; then to do the same again and again. Once they had enough, they would zoom from face to face [see Figure 1]. The smooth zooming and extremely large surface offered children an experience they called "a ride". Many times while zooming, the children would make what they called "zooming noises" (e.g., brrrrrrrrrrr, ziiiiiiiiiing, zooooom). In addition, they would tell stories while zooming: "Once there was a boy who had lots of friends. When you zoomed into his eye you could see his friend Fernando. When you zoomed into Fernando you could see his friend Jean. And when you..."

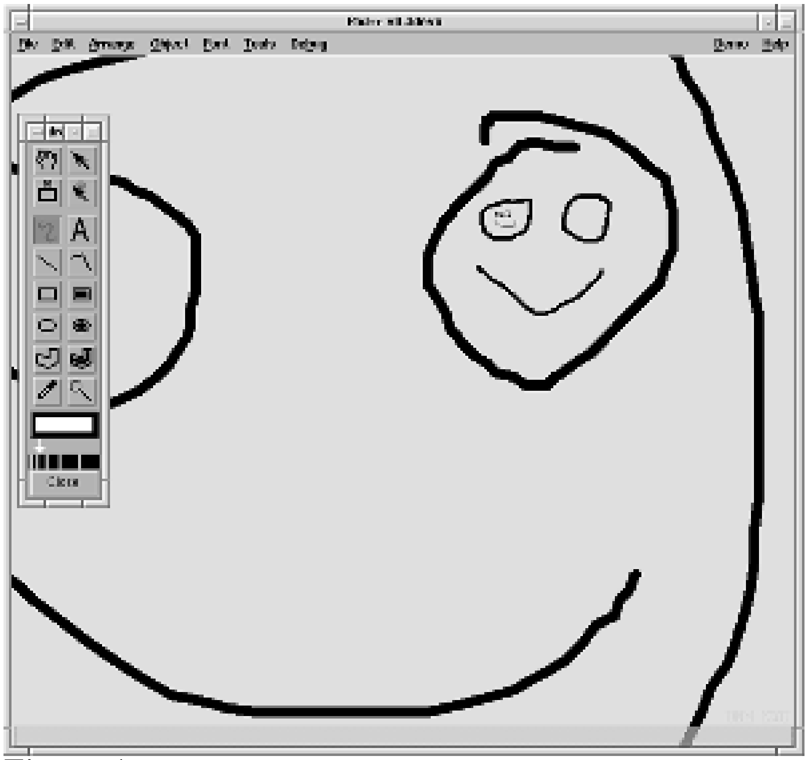

Figure 1

Another activity the children continually wanted to do was create "X-Ray" stories. What they were referring to was the lens technology in Pad++. To the children, lenses helped them see what information was inside of a picture or text. Children simply placed what looked like an empty box over a picture. When the box was placed over that picture some "hidden information" was seen [see Figures 2 and 3]. For example in the case of a cow picture, when a lens was dragged near or over it, the word "moo" appeared. Thanks to these very basic activities, we saw a number of possibilities for the development of a zooming environment that supported children's learning activities. First and foremost, we saw that children wanted to tell stories. And what came as a surprise to us, was that the activity of zooming strongly supported the creation of non-linear stories. It seemed to be a very natural way for children to tell their stories. They enjoyed the freedom of piecing together their thoughts and connecting them any which way they wanted to by zooming. This zooming approach to story-telling also strongly supported collaboration between children. Many times one child would begin the story by typing or drawing, and another child would add the next part of the story in another part of the Pad surface. In this way, children would work together endlessly writing, drawing, zooming, and telling their stories.

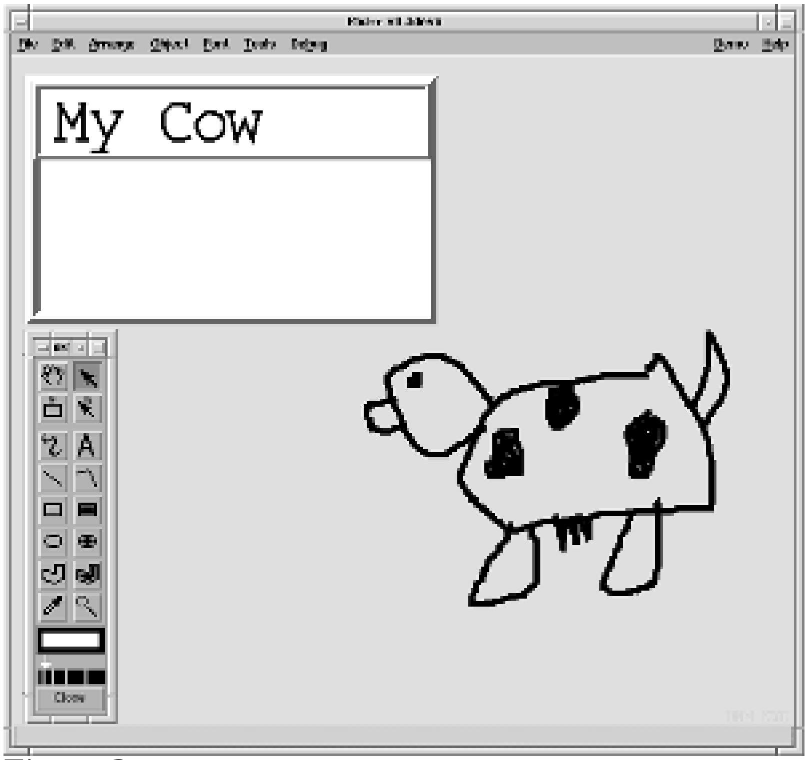

Figure 2

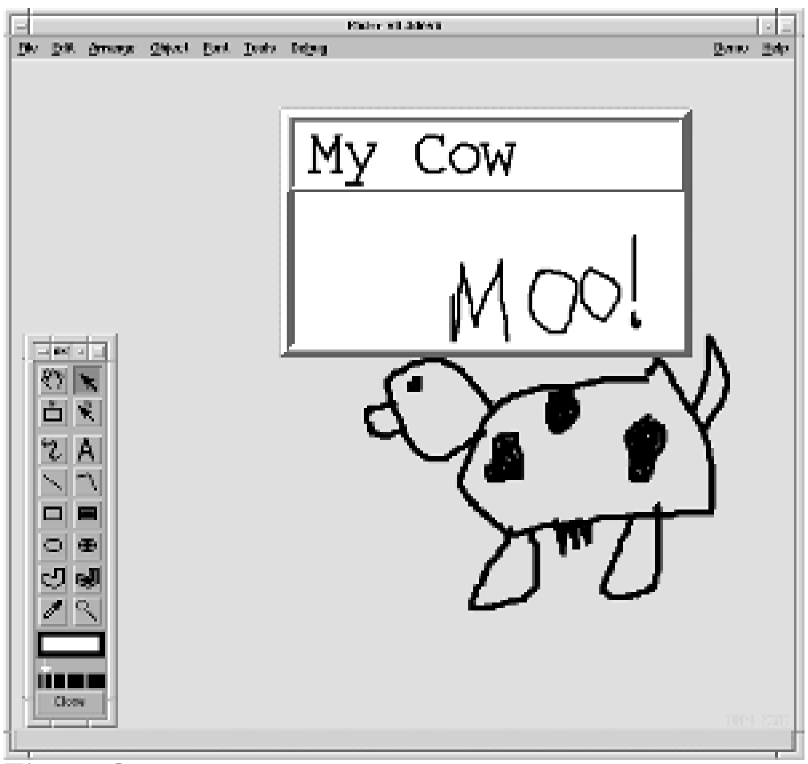

Figure 3

For the children, these activities developed and exercised their visual and verbal literacy skills, and enabled some proficiency with their use of new technologies. For us as researchers, these experiences made clear that the children needed zooming story-telling tools that suited their needs. To begin with, they wanted a better way to "program their zooms" between story elements. It was far too easy for the children to become lost on the Pad++ surface when zooming in the wrong direction. The children also seemed to need different drawing tools for their story-telling. When using the existing palette of drawing tools in Pad++, they easily became confused with all the extraneous tools not necessary for their drawing or writing. They also had a difficult time when they would zoom on the Pad++ surface and weren't sure why the drawing tools "lived in a different box from the rest of the things in the zooming world". They didn't like moving the floating menus around the Pad++ surface. "They're always in the way of our zooming," said one child. In addition, there were times that the children also seemed to need our help in getting started on their stories. They often would ask, "Start me a picture, please?" With this in mind, we also tried to consider new ways of offering story resources.

The Local Tools and KidPad

After a short intense period of development, researchers came back to the classroom with the first version of what we called "KidPad". It included a new interface paradigm we called "Local Tools" [3]. Instead of traditional floating palettes of tools, there were large, simple tools that sat directly on the Pad++ surface [see Figure 4]. They reminded a number of children of the "fat pencils they could write with if they were good". With local tools, children could select a tool (by single-clicking on it), and the cursor would turn into that tool in both size and shape. If the child wanted to drop that tool and use another, the child would double-click in the place they wanted to drop it and the tool would remain in that place on the Pad++ surface.

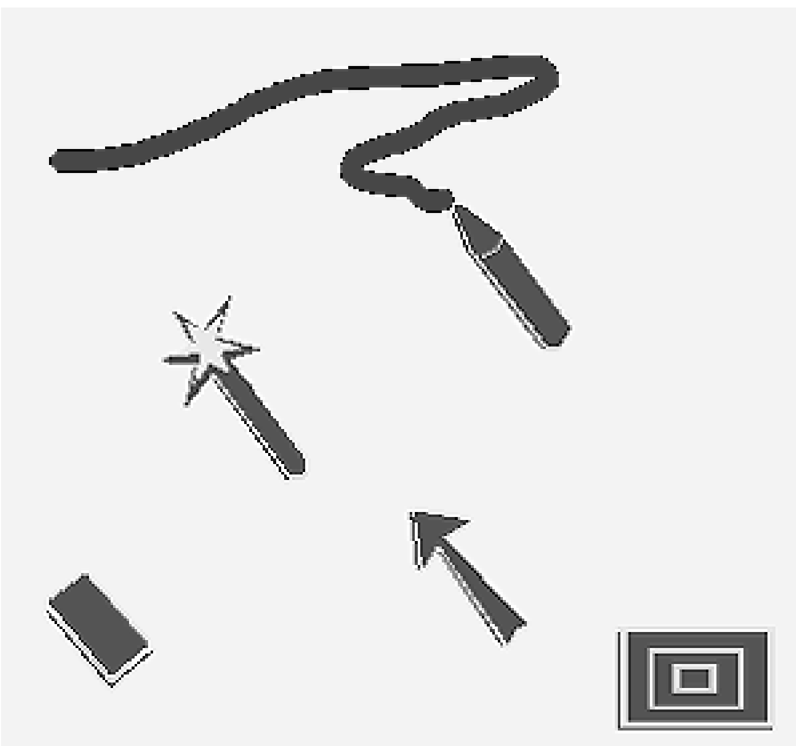

Figure 4

These tools included what the children called a "crayon" to draw with, an "eraser" to delete objects, and an "arrow" to select objects [see Figures 4, 5 and 6]. The arrow was used in combination with the picture scrapbook. This scrapbook consisted of a slider to move through pictures which ranged from green dinosaurs to red hats. Once the child saw what they wanted, they chose a picture with the arrow, and dragged the picture onto the Pad surface. Automatically a copy of the picture would be placed on the Pad surface.

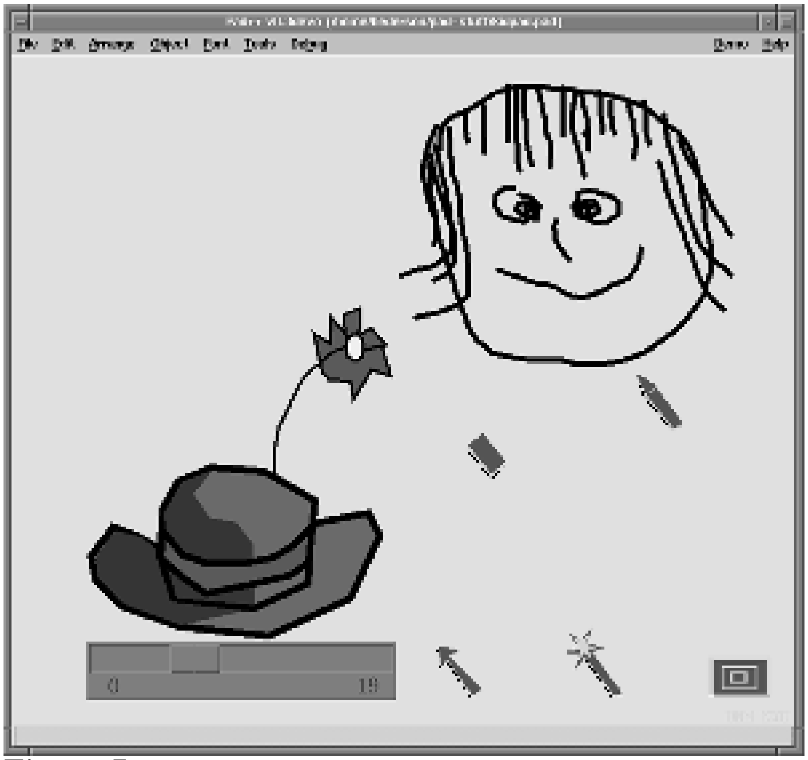

Figure 5

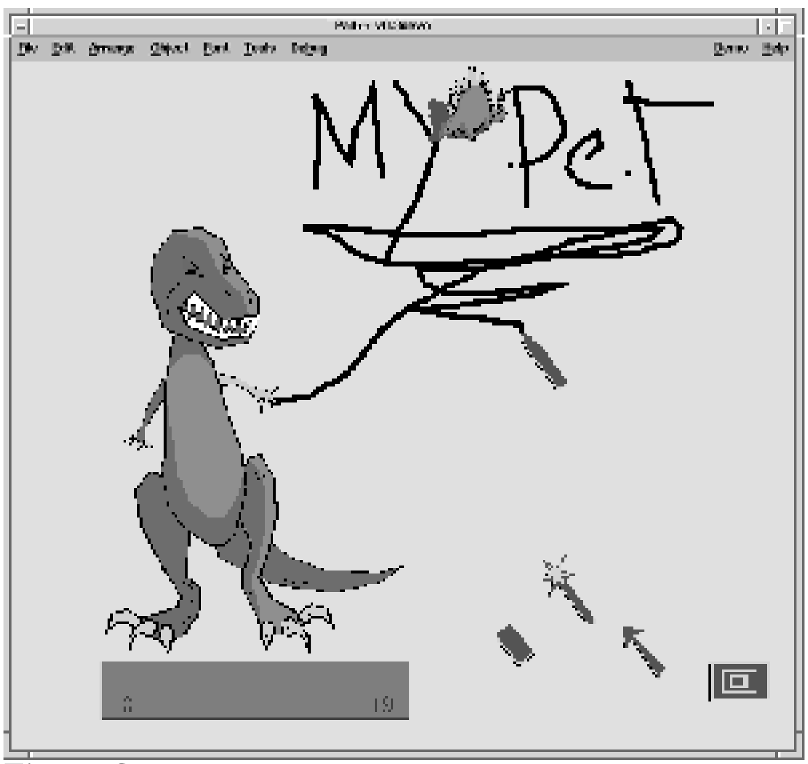

Figure 6

Another local tool was the "magic wand". In response to the children's love for zooming, and their frustration with getting lost "on a long zoom" the magic wand was created. When children selected the wand, then selected anywhere else on the Pad++ surface, a link was started. The next place children selected was the place that would be "linked to". These two places could be seen easily because a bright yellow line connected the two selections. When children de-selected the magic wand, they could zoom between links by touching a "hot zooming spot" with another tool. Children seemed to love this tool. While similar functionality was available in the Pad++ substrate, the interface was not intuitive to children, and therefore was used very little. Once this became a magic wand with "yellow magic lines" showing where there would be zoom paths, the children used this tool repeatedly to tell stories.

In addition to these local tools, there was a "tool box". This box was placed in the bottom right corner of the screen. When children clicked on it, all the local tools would zoom back to where they started, lined up along the bottom of the screen. This turned out to be extremely useful when children would zoom around the Pad++ surface and forget where they left their tools.

Children's KidPad Design Ideas

The children seemed to enjoy this new zooming environment. Their stories became more complex and richer in content and structure, thanks in part, we believe, to the local tools they used. Once the children had spent some time with this new environment, we asked the children to brainstorm with us on how to make a better technology for them [see Figures 7 and 8]. What we heard from them in conversations, drawings, and writing were the following suggestions (these suggestions are only listed if a majority of the children we worked with raised the issue):

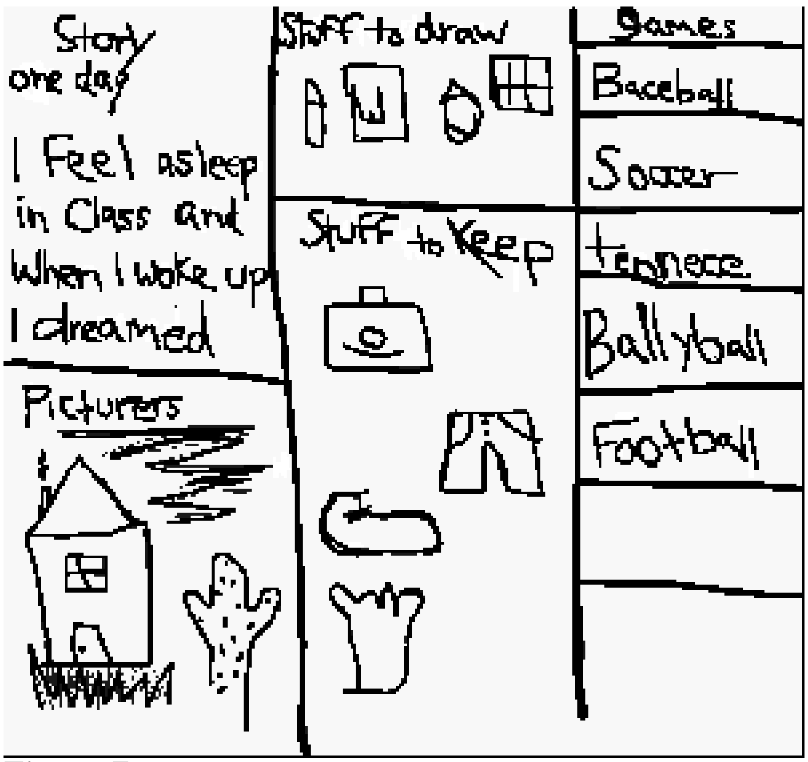

Figure 7

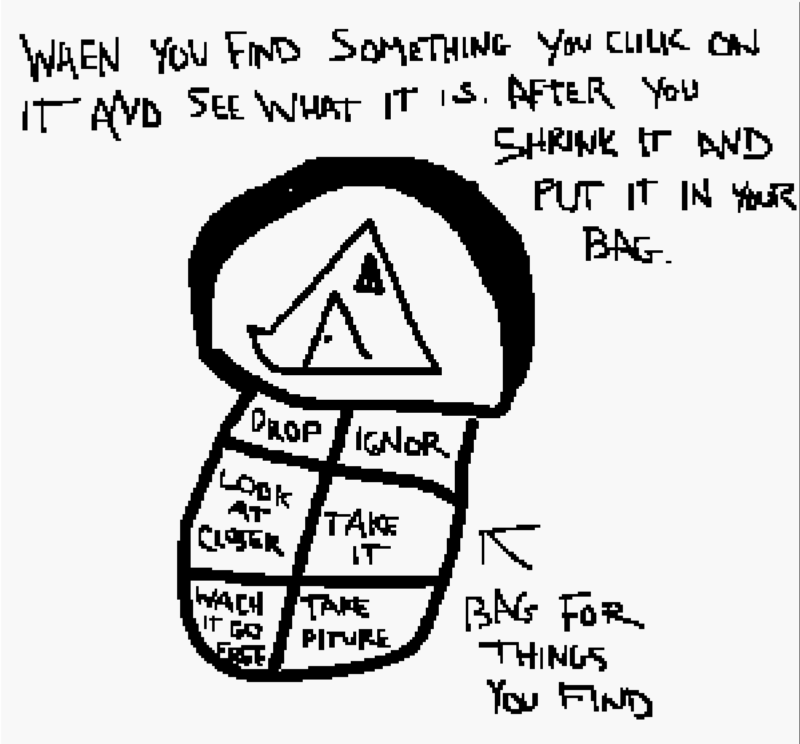

Figure 8

Hardware:

- They wanted to draw directly on the screen (a.k.a. a touchscreen).
- They wanted to turn the mouse into something else besides your typical mouse (e.g., a rocketship, car, an animal) to make it easier to zoom (many children with small hands found it difficult to use a 3-button mouse).
- They did not like to double-click the mouse (it was a difficult motor-coordination skill for children). They wanted an easier way to "drop tools".

Software:

- They wanted sound for their stories.
- They wanted zooming to take you back in time instead of space (zoom through history).
- They wanted to use zooming, to zoom into different worlds (e.g., a game world, a story world, a numbers world, a drawing world).
- They wanted additional drawing functionality: a writing (typing) local tool, a ruler (to make straight lines), more colors for the crayon, and paint brushes.
- They wanted dictionaries to help spell their words.
- The wanted to animate their drawings.
- They suggested additional types of pictures be added to the scrapbook: animals, outerspace planets/creatures, plants, people (from different ethnic backgrounds), clothes, hearts, houses.

Up until this brainstorming experience, we had generally chosen to focus our development efforts on "the biggest problem of the week". At our classroom sessions with children (usually an hour, three times a week) they would show us where they had difficulties, or suggest new possibilities. These were generally not large development projects, but small areas that could quickly be implemented and tested with the children. However, once examining the results of our children's brainstorming work, the team went back to the lab to decide what features seemed to suggest important new directions for the future. What follows is a discussion of where the children's ideas have taken us.

KidPad for Preschool Children

Thanks to the abundance of ideas from our child design partners, we found ourselves (due to limited programming resources) having to focus on a few areas of development. One important area that the children pointed out was zooming. We heard and observed that the 3-button mouse was confusing and difficult to use for many of our children. By making the left button the select button, the middle button the zoom-in button, and the right button the zoom-out button, we found that children usually had to depend on trial-and-error to remember which button did what. The mice that the children drew had whiskers and noses for zooming, which we suspected might be much easier to remember than right button or middle button. Many of them just wanted to get rid of the mice all together and point at the screen. Listening to their concerns, we began to focus on alternative zooming and panning tools that lived on the screen. We created a "zoom in" and a "zoom out" local tool [see Figure 9]. By picking up a zoom tool, the cursor became that tool. Moving and pressing it would zoom at that spot. We also developed a "panning frame" which enabled children to merely move the mouse over the frame in the direction they wanted to go and the pad surface would pan in that direction [see Figure 10]. Each of these tools had the additional feature of animating when the cursor was over it. We came to the conclusion that local tools should not have a text label, thus accommodating younger children. We decided that these tools should only be icons, and that animating the icons would replace the need for text [1]. The zoom and pan tools proved to be excellent in their self-explanatory nature.

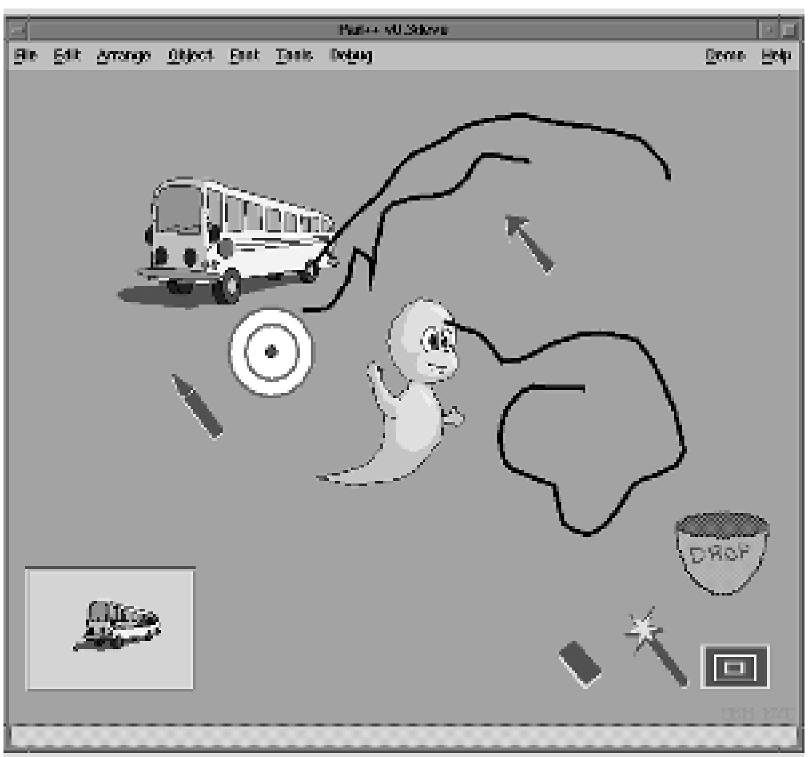

Figure 9

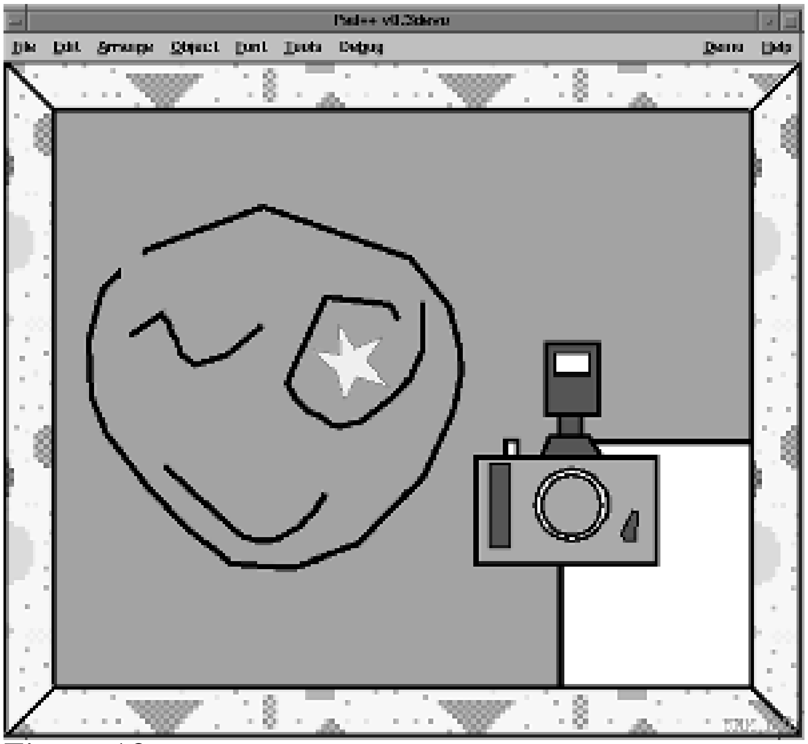

Figure 10

In addition to these tools, we tried developing a "drop bucket", one which would replace the need for double-clicking to drop a tool. However, we quickly saw and heard from children that this drop bucket was not the right solution. The "dropping" was an unnecessary step to the children. Instead, they wanted to "swap tools" . They wanted to merely click on another tool and have that tool become the cursor and have the previous tool be put on the Pad++ surface. We took this to heart and quickly implemented this interface suggestion. Interestingly enough, our preliminary results with this version of KidPad show that these new features, (except for the drop bucket) seemed to be much more intuitive for children. In fact, it appears from our pilot tests with a small number of children ages three and four, that much younger children were able to use these KidPad tools.

KidPad for the Future

What does the future hold for KidPad? There is still a great deal of work ahead, even to fulfill the initial design suggestions we received from the children. In a perfect world, we would love a 1,000 more hours with hundreds of more children, in a relaxed setting outside of the structure of a typical classroom. But without more resources for personnel and facilities, we have continued on with our small group of researchers, finding access to classrooms and children where possible. Currently, our energies are focused on more short-range areas of development that support the needs and desires of our child design partners. We are in the process of expanding the drawing tools, developing sound capability, simplifying the "X-Ray" interface, and adding animation functionality. We also would like to see two more long-range additions to KidPad. The first addition would be in automating the drawing process. We call it the "DrawMe" tool. It is envisioned that a child could use this to replicate and modify existing objects more easily. A child could select the DrawMe tool and place it over a given drawing. When the child clicks on the drawing, all the local tools that were used to create this drawing would gather right below the picture selected. For example, a child might select a picture of a pumpkin. And what s/he might get with the DrawMe tool would be an orange crayon, black ruler, and the eraser gathered below the pumpkin. This would help the child remember what tools s/he used to create that picture. In addition, it would also show the child how other children created their drawings, thus spurring on new ideas to pursue. Once any of the tools gathered directly below a picture were used, they would function as in the past to create a new picture.

The second set of functionality we see as important, is to support new forms of collaboration between children. In much of our work we saw children sharing one computer. Many times they were frustrated when they could not agree who would get to use the mouse to zoom or to draw. We observed that more assertive children would tend to monopolize the use of the computer, frustrating more passive children. Therefore, we hope to implement software and hardware support for two mice on one computer. In this way, a computer might better support the work of two children sharing the same Pad surface. This is interesting to us, not only from the standpoint of children's story-telling endeavors, but in terms of new collaboration functionality for the Pad++ substrate.

SUMMARY

In summary, we believe that not only has our research been furthered in the area of new technologies for children, but our understanding of how to work with children as our design partners has been expanded as well. In addition, our development work on the Pad++ substrate has also benefited. Thanks to suggestions from our child design partners, we have simplified the hyperzooming tool and the "X-Ray" or lens tools in Pad++. In addition, we have continued our exploration of "Local Tools" in new areas such as layout and design for adults. We have found that children have a lot to offer, not only when it comes to helping design new technologies for them, but in designing new technologies for adults as well.

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