Abstract
MOOSE Crossing is a text-based virtual world (or "MUD") designed to support the development of a "constructionist learning culture."[1] Children from a variety of geographic and cultural backgrounds will connect across the Internet to collaboratively build a virtual world. As part of this research, I am developing a new programming language (called MOOSE) and client interface (called MacMOOSE) designed to make it easier for children to create new places and objects. The virtual world, MOOSE Crossing, will be opened to 300-1000 children aged twelve and under on the Internet. Through analyzing the children's learning experiences, I will be able to explore the potential of the combination of construction and community. In what ways can community support and enhance constructionist learning? I will study the learning which takes place in this environment through two techniques. First, I will analyze the artifacts the children create and logs (recorded with informed consent) of what takes place in the virtual world. Second, I will work closely with one local group of children, and use an ethnographic methodology to explore their learning experiences. The goal of the MOOSE Crossing project is to create a new type of constructionist learning culture, and observe that culture to shed light on the power of the combination of construction and community.

> *"They dance together and as they dance everyone is learning and teaching as well as dancing. Even the stars are there to learn their difficult parts."*(Papert 1980)

1. INTRODUCTION AND BACKGROUND

1.1 A Technological Samba School

In samba schools in Brazil, members of a community gather together to prepare a performance for carnival. People of all ages learn together, as a community. "Let me show you something," says one dancer to another. Learning is not dictated by a set syllabus, but is spontaneous and authentically motivated.

In *Mindstorms*, Seymour Papert has a vision of a "technological samba school." It's not the content being learned in samba schools, nor the efficacy with which it is mastered that enchanted Papert—he is not advocating dance as subject matter, and he does not comment on whether the participants become particularly good dancers. Rather, he is inspired by the different relationship to learning the members develop, and the way in which learning becomes a community process.

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[1]See section 1.3 for a discussion of the notion of a learning culture. It would be more accurate to say, "a collection of learning cultures," since most cultures are composed of varied sub-cultures.

Could there be a technological samba school—a place where people are meaningfully engaged with computational ideas, working as a community on projects that they care about? Papert highlights a number of features of samba schools he sees as important. In samba schools, learning is:

- self-motivated,
- richly connected to popular culture,
- focused on personally-meaningful projects,
- community based,
- an activity for people of all ages to engage in together,
- life long—experts as well as novices see themselves as learners, and
- situated in a supportive community.

Text-based virtual worlds on the Internet can have each of these features. For historical reasons, these virtual worlds are called "MUDs" or "Multi-User Dungeons." In the late 1960s, natural language processing researchers Will Crowther and Don Woods wrote ADVENT, the first text-based adventure game (Raymond 1991). In the late 1970s, multi-player versions were built for the ARPAnet.[2] People from all over the world connected to these "Multi-User Dungeons" to play a text-based form of the game Dungeons and Dragons. In 1989, a graduate student at Carnegie Mellon University named James Aspnes decided to see what would happen if the monsters and magic swords were removed.[3] People's chief activity became trying to extend the virtual world, rather than conquer it.[4]

Most people do not view MUDs in terms of learning; however, the ways in which MUDders are constructing worlds together has resonances with the constructionist theory of education, an approach to learning first articulated by Papert (Papert 1991). Constructionism involves two types of construction. First, it asserts that learning is an active process, in which people construct knowledge from their experiences in the world. (This idea is based on the theories of Jean Piaget.) To this, constructionism adds the idea that people construct new knowledge with particular effectiveness when they are engaged in constructing personally-meaningful products. They might be constructing sand castles, LEGO machines, computer programs, or virtual objects. What's important is that they are actively engaged in creating something that is meaningful to themselves and to others around them.

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[2]Numerous multi-user games based on the Dungeons and Dragons role playing game appeared in 1978-1979 including Scepter of Goth by Alan Klietz and MUD1 by Roy Trubshaw and Richard Bartle [email conversation with Alan Klietz, March 1992].

[3]Electronic mail conversation with James Aspnes, February 29th, 1992.

[4]As of October 1994 , there were more than 300 active, publicly announced MUDs on the Internet. Most MUDs are still dungeons and dragons games.

MUDs combine construction with community. In an informal ethnographic study of twelve adults who learned to program for the first time in a MUD, I found that the community provides motivation for learning, technical support, and emotional support for the technophobic (Bruckman 1994). In this "community-based learning," teaching is often a reciprocal relationship that takes place among peers, rather than a one-sided transmission from experts to novices. These virtual communities are promising test-beds for exploring a new vision of learning—a vision that is more like samba schools at their best, and less like the stiff, stifling regimens that exist all too frequently in traditional schools.

Could MUDs become a kind of technological samba school? The potential is there; however, most existing MUDs suffer from the poor quality of software tools available, lack of guidance by an educational vision, and lack of careful study. In this thesis, I hope to rectify these problems through the creation and study of a virtual world for children called "MOOSE Crossing." MOOSE Crossing includes a new programming language I have developed called "MOOSE" designed to make it easier for children to program in the virtual world, and a client program called "MacMOOSE" to make working in that language less awkward. The initial virtual world will be seeded with coding examples, and structured into areas for the children to extend—for example, one store front is an invitation and context to begin to build a town. I will open MOOSE Crossing to 300-1000 children aged twelve and under on the Internet, and study what emerges. Using an ethnographic methodology, I will work closely with one group of children. I will also analyze artifacts the children create, and logs of activity and conversations in the virtual world, recorded with informed consent. Through analyzing the children's learning experiences, I will be able to explore the potential of the combination of construction and community. In what ways can community support and enhance constructionist learning?

1.2 MUDs as a Media Form

The fantasy worlds of MUDs are closely connected to popular culture. Researchers in cultural studies have shown that popular culture plays an important role in children's learning. Children take stories from popular books and other media forms, and make them their own, using them to make sense of their daily experiences (Wolf and Heath 1992). Henry Jenkins documents the way young children not just watch but interact with the television show "Pee Wee's Playhouse." He writes that "children draw upon the prefabricated characters and situations of popular culture to make sense of their own social experience, reworking them to satisfy their own needs and desires. The children's manipulation of these televisual materials rarely stops when the broadcast does. Rather, program content is fragmented and dissected and the most meaningful bits, 'the good parts,' are integrated into the child's other play activities, into dreams and into waking thoughts." The

children "feel little compulsion to remain faithful to the original," instead reappropriating those cultural materials to make very personal meanings (Jenkins 1988). At its best, popular culture is a starting point for the child's own creative process.

In addition to viewing MUDs as learning environments, we can also view them as a new media form. MUDs can be compared not just to school, but also to television and books. A television viewer is a recipient of commercially produced content. A MUD player is a collaborative creator of media content.

In "Xylophones, Hamsters, and Fireworks"(Resnick 1991), Mitchel Resnick documents how popular culture was a jumping-off point for LEGO/Logo projects. One elementary school teacher had never built anything out of LEGO before and described herself as feeling uncomfortable about science. However, her desire to build a carousel like the one she rode on as a child inspired her to learn enough about gears not only to make the carousel go around, but also make the horses move up and down. Her love of carousels became a path to developing a new relationship with technology.

Similarly, in the "Game Design Project," Yasmin Kafai found that she could leverage off of children's love of video games to encourage them to be more meaningfully engaged with computer programming, math, and science (Kafai 1993). MUDs leverage off of children's fondness for not only games but for all forms of popular culture. Characters and places from literature, comics, and television become starting points for children's creations in the virtual world. Like LEGO/Logo and the Game Design Project, MUDs amplify children's natural tendency to re-purpose stories, redirecting their enthusiasm for popular culture from an act of consumption to one of creation, and to engagement with both linguistic and technological creativity.

Two key points emerge from viewing MUDs as a media form. First, it is important to note the ways in which popular culture serves as a starting point for an individual's creativity. Second, although research in cultural studies strongly indicates that viewers are active creators and not passive recipients of meaning, one can draw a distinction between media forms in which the text itself is produced by the users versus more traditional media forms in which the text is produced by a publisher or broadcaster. In many media forms on the Internet including many MUDs, users are creators of content.

In this respect, the emphasis that cultural studies (especially British cultural studies) places on analyzing people's original cultural productions (Jenkins 1992) has clear resonances with the emphasis researchers in constructionist education place on learning through making things (Harel and Papert 1991). Both disciplines view individuals as empowered by the media they reappropriate, and see a person's creative productions as a site of resistance to

dominance by corporate or institutional interests—by publishers, broadcasters, or schools.

1.3 Learning Cultures

In MOOSE Crossing I hope to create a learning culture. Two definitions of the word "culture" are relevant:

> "5. the behaviors and beliefs characteristic of a particular social, ethnic, or age group: *the youth culture; the drug culture.*
> 6. *Anthropol.* the sum total of ways of living built up by a group of human beings and transmitted from one generation to another."(Flexner 1993)

I would like to define "learning culture" as the beliefs (especially about learning) characteristic of a particular group of people at a particular time, and the way those beliefs are embodied in the complete way of interacting of the group.

Any environment is a form of learning culture; one could analyze the learning culture of a particular classroom, or even a public space like a park or a bus stop. However, I wish to use the term primarily to denote a particular kind of learning culture—one inspired by constructionist principles. I will sometimes use "constructionist learning culture" and "learning culture" interchangeably.

Figure 1: Calvin in school: an unfortunately realistic depiction (Watterson 1991).

Unfortunately, negative views of learning are common in the culture of many educational institutions. Too often children feel imprisoned rather than empowered, trapped in the classroom like Calvin thinking "what do they want of me?" (Figure 1) Learning and traditional classroom learning are commonly conflated, and the child's frustrating experiences in school foster negative feelings about all forms of learning. Constructionist learning cultures seek to change the child's relationship to learning, fostering self-

directed and self-motivated learning, so they instead will think "this is what I want for me!"

I experienced one innovative, constructionist learning culture first-hand as a child. When I was a teenager, I used to say I grew up a year's worth each summer at camp, and then stagnated over the rest of the year. From the summer I was eleven through the summer I was eighteen, I participated in a remarkable learning culture called Buck's Rock Creative Work Camp in New Milford, Connecticut.[5] I will describe the features of that experience that I hope to emulate and push further in MOOSE Crossing.

Activities at Bucks Rock center around the creative arts. Over the eight summers I attended, I blew glass, wove a blanket, made soft sculptures of batiqued fabric, edited and wrote stories for a magazine, acted in a play, adopted a goat, planted and cared for a vegetable patch, and made many things out of wood: bowls turned on the lathe, a recipe card cabinet for my mother, a jewelry box. I spent most of my time in the wood shop, because I liked the people there, and loved the smell and texture of wood.

A key feature of Buck's Rock is its lack of schedule. Campers must participate in some activity each day, but it can be any activity. No one minded that I spent most of my time at the wood shop—it is perfectly allowable to spend an entire summer at one activity. No one tells children where to go, or even checks where they've been. Adult counselors, professional artisans in each of these areas, arrive at their activity each morning, ready to help whoever happens to show up. Consequently, all the campers at an activity want to be there—that activity is their first choice from a rich variety of options. As a result, attitude and motivational problems are rare. Furthermore, campers have ample time to develop a meaningful engagement with the activities that interest them—they aren't shuttled off to the next area when the clock strikes the hour.

Each activity or "shop" at Bucks Rock has its own culture. It was the company of my fellow wood enthusiasts that drew me there, as much as the process of working with wood. I can still describe the personality type attracted to each activity. For example, one extreme type are the glass blowers. At the glass blowing shop, only two people can use the furnace at a time. It's a wonderful activity to watch—the shop always attracts a crowd who look on, chat, and gossip. You have to wear dark glasses to blow glass, and many regular glass blowers seemed to have a dark glasses sort of attitude—much of glassblowing struck me as sitting around and acting cool. I preferred the wood shop next

[5]Bucks Rock was founded by Dr. Ernst Bulova and Mrs. Ilsa Bulova during World War II, as a haven for British children fleeing the bombing of London. At the time I attended in the late 1970s and early 80s, it was directed by Sybil and Lou Simon. During the academic year, Lou was then also the principal of the High School of Music and Art in New York City.

door, where folks were more down to earth. At the wood shop I found friends based on common interests and temperament, rather than being stuck in an arbitrary grouping based on gender and age. Within most communities are sub-communities with distinct cultural features. I should perhaps refer to MOOSE Crossing as a collection of "learning cultures," not a single, monolithic culture.

What would it be like to structure a school rather than a summer camp in this way? The "Friskolen 70" school in Denmark is just such a school, and was studied by Aaron Falbel in his dissertation "Friskolen 70: An Ethnographically Informed Inquiry into the Context of Learning" (Falbel 1989). At Friskolen 70, there are no classes or groupings of children by age or ability. There aren't any classrooms—most of the school building is one open space (a former stocking factory), with wooden beer cases that can be stacked and restacked to create areas for special purposes, as needed. Children arrive in the morning and do what they please. Teachers are available to help the children pursue what interests them. The character of the place is captured in this excerpt from Falbel's field journal:

> "Maria (11) and Johanne (9) are using the wood-burning set in the workshop to make Christmas presents for their friends and relatives. Maria has just completed a small, wooden tic-tac-toe game for a cousin of hers in Sweden. The X's and O's are made out of wooden pieces that fit neatly into a finely crafted playing board. She is etching an inscription to the recipient of the gift on the back of the playing board when little Clara (6), who just started at the school at the beginning of the month, wanders by and is drawn into the scene. She watches Maria etch a floral design under her inscription and is fascinated by the strangeness of this smoldering writing instrument. Maria notices the presence of Clara and displays for her the finished product. Clara turns over the board and feels the grooves of the inscription with her fingers. Maria asks her, "Can you read?" Clara shyly shakes her head no. Maria smiles and says "Come," and she motions for Clara to come sit on her lap. Then, very slowly and sweetly, Maria sounds out the words as Clara guides her fingers over the dark-brown letters. Clara is totally absorbed: her face conveys an expression of rapt concentration, her mouth partly open, and her cheek leaning against Maria's arm. The entire episode lasts not much more than a minute. It is so effortless, natural, and unself-conscious that to call it "peer tutoring" would be to debase the beauty of the situation."(Falbel 1989)

It is certainly a much more radical decision to use this open, student-directed style for a school than for a summer camp, and some open questions remain about its effectiveness. Falbel himself is careful not to put the school forward as a model. However, experiences at Friskolen 70 raise a number of important issues about the complete social context or "culture" of learning.

Friskolen 70 and Buck's Rock share a number of features I plan to incorporate into MOOSE Crossing:

- All participation is self-motivated,
- Children are trusted to monitor themselves,
- Adults are present as facilitators,
- Self-selection leads to peer groupings based on common interests rather than gender or age, and
- Interaction with peers is a key component of the learning experience.

These features are at the heart of constructionist learning cultures.

1.4 Educational MUDs

An increasing number of educational MUDs are being founded. Most are designed to teach college composition. Examples include DaedalusMOO, Diversity University, LitMUSH, and WriteMUSH. I know of two MUDs designed to be learning environments for young children: MicroMUSE and MariMUSE.

MicroMUSE is the oldest and largest MUD for kids. It was founded by Stan Lim in 1990, and leadership of the project was soon taken over by Barry Kort. Its official charter states that "MicroMUSE is chartered as an educational Multi-User Simulation Environment (MUSE) and Virtual Community with preference toward educational content of a scientific and cultural nature."(Ender 1993) Anyone with Internet access can join MicroMUSE. Both adults and children participate.

MariMUSE is a project of researchers at Phoenix College in Arizona, working with Longwood Elementary, a local elementary school serving a population of at-risk primarily Native-American and Mexican-American children. While MicroMUSE is open to anyone on the Internet, MariMUSE serves a small, local population. During the summers of 1993 and 1994, students were bused to a computer room at Phoenix College for three hours each day. They interacted primarily with one another, but also with adults who volunteered to log on and spend time with the children.

I had the opportunity to visit Longview and meet the MariMUSE students in March of 1994. I was impressed with the creative writing and design of virtual rooms the students had done. One fifth grade boy built an airplane hangar. He carefully researched the details of each plane, and asked the school librarian to order more books about airplanes. A fifth-grade girl built a many-roomed mansion. In real life, her family lives in a homeless shelter.

However, none of the students I met at Longview had done any programming. One girl had designed a horse, but the "ride horse" command

didn't work. We looked at the code together, and I asked her how it worked. She replied that she didn't know—an adult had typed it for her. MUDding without programming misses an important learning opportunity. Programming opens up new design opportunities for children within the virtual world, and provides a context for developing a meaningful relationship to mathematics, computer science, and technology in general (Soloway, Guzdial et al. 1993).

An informal exploration of MicroMUSE shows that while a wealth of creative writing is occurring there, only a handful of exceptional children are doing any programming. This is probably as a result of the awkwardness of the MUSE language. A better programming language is needed.

Furthermore, no careful research has been done on what children are or are not gaining from these projects. Critical analysis is needed.

1.5 Pilot Study

In October of 1992, I began working on a MUD designed to be a professional community for media researchers which I called MediaMOO (Bruckman and Resnick 1993). MediaMOO opened to the public in January of 1993, and as of December 1994 had over 1100 active members from 29 countries. MediaMOO is based on the MOO software, developed by Pavel Curtis of Xerox PARC (Curtis 1992; Curtis 1993; Curtis and Nichols 1993). Constructionist ideas have informed the design of MediaMOO. The virtual world of MediaMOO is built by its inhabitants. Unlike most MUDs, all members are given full programming privileges, and are encouraged to learn to program. Experience designing and managing MediaMOO has guided the design of MOOSE Crossing, serving as a pilot study.

As part of the MediaMOO project, I conducted interviews with twelve adults who learned to program for the first time on a MUD (eight on MediaMOO; four on other MUDs) (Bruckman 1994). Those interviews provided significant insight into the type of learning that takes place in MUDs. For example, one twenty-year-old undergraduate biology major who I will call Lynn programmed a fan, like the one she uses in Chinese folk dancing club. She designed it so that when she uses it, the results are graceful; when someone else attempts to use it, it falls clumsily on the floor, as her fan often did when she was first learning this type of dance. Before Lynn discovered MUDs, she took one programming class taught in Pascal in college, which she did not enjoy. On MediaMOO, her projects had more significance to her:

> In Pascal it was kind of frustrating. They would give you challenging ones and then when I finished it it was satisfying but in a different way.... In this way [on the MOO], it was something that I wanted solve, something that I wanted to make. Something that would give me

> satisfaction after I finished it. Some of the programs I did in Pascal like the word alphabetizer or taking a bunch of text and organizing it, I would never use that. And it doesn't really have any significance to me. But in the MOO something that I wanted to do—that I wanted to show people, about myself—I could program it.
>
> The kind of programs I had in the class, they were kind of interesting and it was neat to be able to make the kinds of program they gave you the problem for. But I think in the MOO this whole idea of having a virtual world, and having your own things, and making your own things, and setting up your identity on the MOO—partly through using these things—I guess gave me the drive to make it work, and whenever I ran into a bug to really ask people "how do you fix this?" I guess maybe having a personal connection or ownership of the objects.

Lynn felt a greater personal connection to her projects on MediaMOO, compared to the assignments from her undergraduate computer science class. She was inspired to work further on her projects, and supported in those efforts by other people in the virtual world. Most MUDders remembers being new and receiving help from others, and are happy to help new players. There is almost always someone around who is eager to help. A number of people helped Lynn with her project, especially a researcher at Apple Computer named Eric. Lynn and Eric became friends. She was excited to develop a friendship with someone older, and enjoyed asking Eric questions about his job. When Lynn traveled to California one summer, she visited Eric at Apple. She describes people at her college as "pretty homogeneous." Online she has developed meaningful friendships with people she would not normally meet.

Lynn is proud of her programming accomplishments. She says, "When I got my fan working, I went around showing everyone." In addition to providing technical assistance and critical feedback for work in progress, members of the community also form an appreciative audience for completed work.

Lynn's experiences online had a significant impact on her. She had previously been half-heartedly considering applying to medical school, but now is enthusiastically pursuing a career researching the social side of computing and human/computer interface design. She credits her MUD experiences with inspiring this interest. It is certainly gratifying that the virtual community could inspire a student, particularly a woman, to pursue a career in the computing field. However, the goal of using MUDs educationally is certainly not vocational. Lynn's story is a good example of several positive features of MUDs as learning environments. For Lynn, the virtual community provided:

- Motivation for learning,

- Emotional support to overcome technophobia,
- Technical support,
- An appreciative audience for her work.

1.6 A Hypothetical Scenario

One main goal of the MOOSE Crossing project is to bring this sort of learning experience to children. Extrapolating from the pilot study, one can construct a hypothetical scenario of a child's learning experience on a MUD designed for kids:

After school each day, Jane, who is eleven and lives in a suburb of Seattle, spends two hours at the community center, until her parents are done with work and can pick her up. Each day she picks which activity she'd like to participate in. Usually, she goes to draw with the art group, or outside to play dodge ball with the sports group if the weather is nice. Coming back from dodge ball the other day, she passed by the computer room, where her friend Sarah was still sitting at the keyboard, even though it was time to go home. Sarah called Jane over, "Jane, Jane! You gotta check this out! I'm talking to someone in Los Angeles!"

Jane looked over Sarah's shoulder as she chatted with Julio and Anna. Sarah asked if they know any movie stars, and Julio said he was friends with Arnold Schwarzenager. He also said he had seven pet cats. Sarah said she didn't believe Julio really had that many cats. Soon it was time to go. They agreed to meet again online at the same time the next day. The computer teacher, Mr. Smith, asked if Jane wanted to try MOOSE Crossing too. Jane said yes, so Mr. Smith gave her some information and a permissions form to take home to her parents.

Jane returned the next day with the permissions form signed by herself and her parents, and a week later Mr. Smith told Jane that her own character was ready to be used. Jane chose to go to the computer area a few days a week from then on, and always sat at a terminal next to Sarah's. Jane and Sarah found Julio and Anna logged on, and went to join them. Julio and Anna were in a store Anna had designed in the town of MOOSE Crossing, "Anna's Furry Pets." Julio told Sarah that now he really does have seven cats. In the pet store were seven virtual cats. Three of them were carefully described with different color fur, ages, and sizes. The other four weren't finished yet, Julio explained. Sarah showed Jane how to pet the cats. When Jane typed "pet Fluffy," the little white kitten purred, but when she typed "pet Raphael," the big black cat wagged its tail! Julio apologized and said that he wasn't done making Raphael yet. He had made his cats by adapting code for dogs from the library. Later Ranger_Rachel, an adult computer programmer who volunteers time to work with children on MOOSE Crossing and whose son Tim comes there occasionally, came by to say hi. She showed Julio how he

could make a "generic cat" and have all seven cats inherit from generic cat, so he wouldn't have to make all those changes to each cat individually.

The children decided they wanted to have a pet show. Anna made two pet birds that sing silly songs, and Jane made a pet elephant with pink and green spots that tells elephant jokes. Sarah made an auditorium with a stage, and ribbons for the winners. They announced the show in the newspaper, and soon other children began making pets to enter. The children asked Ranger_Rachel if she would judge the show. She responded that maybe it would be more fun to have everyone vote. The children liked that idea, so Ranger_Rachel helped Sarah write some voting software. Twelve children entered pets, and more than a hundred came to see the show and vote for their favorite. When the voting was over, Jane's joke-telling elephant had won first prize. Sarah is now rewriting her voting program (with a little help from Mr. Smith and Ranger_Rachel) so people can vote in lots of different categories—funniest, prettiest, smartest (best programmed). Julio copied Jane's program and made one of his cats tell cat jokes. The children are planning to have another pet show soon.

The preceding story is hypothetical. MOOSE Crossing is being designed with the aim of making this sort of scenario possible. There are a number of questions one can pose about the children's experiences, starting with concrete questions about what has been learned, and moving to broader questions those answers shed light on:

- Have the children improved their reading, writing and programming skills?
- Which elements of the technological environment (particularly those unique to MUDs and MOOSE Crossing) helped learning? Which elements hindered learning?
- Have children with greater initial strength in one area, either writing or programming, developed in the other area?
- Is there any observable synergy in the way these skills are connected in MUDs?
- Are the children able to express themselves in new ways in this interactive medium?

- Which elements of the social environment (particularly those unique to MUDs and MOOSE Crossing) helped learning? Which elements hindered learning?
- In what ways are children supporting one another's learning experiences?
- In what ways are adults and children supporting one another's learning experiences?
- Have they incorporated feedback from other members of the community in their projects?
- Have children revised and refined projects over time?

- Have they developed a sense of audience, tailoring their creations to a target group of people?

- Has a new type of constructionist learning culture developed? How does this culture compare to other constructionist and traditional learning cultures?
- How do children compare their learning experiences on MOOSE Crossing to those of school?
- Do they see reading, writing, and programming as personally useful?
- Do they have a better understanding of what reading, writing, and programming are good for?
- Do they want to cultivate those skills further?
- Do they feel empowered by their encounter with a constructionist learning culture? In what ways?

All of these questions can be seen as aspects of a core question:
- In what ways can community support and enhance constructionist learning?

Not all of these questions are necessarily answerable; the list outlines the things I hope to look for. Section 2.4 discusses the methodology for investigating these questions.

2. THE MOOSE CROSSING PROJECT

2.1 "MOOSE Crossing"

The "MOOSE Crossing" project includes four major components:
1. The creation of a virtual world for kids on the Internet called "MOOSE Crossing,"
2. A new programming language called MOOSE, designed to make it easier for children to learn to program,
3. A client interface called MacMOOSE designed to make accessing MOOSE Crossing less awkward, and
4. A study of the experiences of children on MOOSE Crossing.

"MOOSE" stands for "MOO Scripting Environment. " The MOOSE language is built on top of the MOO ("MUD Object Oriented") software, developed by Pavel Curtis at Xerox PARC and Steven White. The design of MOOSE is inspired by elements of the languages Logo, Smalltalk, Hypertalk, MOO, and MUSE.

The virtual world built with this software is called MOOSE Crossing. It is a crossing in the figurative sense of a crossroads for children from different socioeconomic and ethnic backgrounds, and different cultures. It is a crossing also in a more literal sense, since when you connect to MOOSE Crossing, you

are at a country crossroads. In one direction, the road leads to the town. In the other, to the city. A path wanders off into the woods, where children can build different sorts of natural environments. At the crossroads is a tree. If you climb the tree, you are in a tree house with public notices and announcements. Up above the tree in the clouds is a place to build areas with fantasy themes. This core is minimally developed; it is a scaffolding to inspire the children to create places and objects. A small forest may inspire children to build a meadow or swamp near by; a general store may inspire a pet store or hair salon down the virtual street. The small number of pre-constructed examples serve as coding examples, inspiration, and context.

MOOSE Crossing will be restricted to children twelve years old and younger. By imposing a maximum age, I hope to reduce the predominance of issues of teenage sexuality in the culture. This will also enable me to give the children greater freedom of speech, because there is a lessened chance of older children introducing much younger children to inappropriate subject matter. Adults and older children will be able to apply to be volunteer "rangers" on the system, serving as mentors and guides. The ranger application essay will ask them to reflect on issues of appropriate conduct, and how and when to intervene in disputes which arise among children.

2.2 The MOOSE Language

One design decision has shaped much of the MOOSE language: the programming language and the command line language should be identical, so that children can try out a command interactively, and put it in their program if it works.[6]

In most MUDs, it is possible to "emote." At the command line, if I type:

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emote smiles.
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Everyone in the room sees:

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Amy smiles.
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Now suppose I want to write a program for my virtual pet dog Rover to wag its tail when you pet it. When I type, "pet rover," I see "You pet Rover," and everyone in the room sees "Rover wags his tail." In MUSE (Wallace 1993), MOO (Curtis 1993), and MOOSE this would be:

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[6]In MOO, the programming language and command-line language are quite different; learning one does not help you learn the other. In MUSE they are identical, but the commands needed to write programs are filled with special characters, and are jammed onto single lines with no line breaks. There are no variables in MUSE—instead of using variables, you store values in registers.

```
[MUSE]      @va dog=$PET DOG:@pemit You pet Rover.; @emit Rover wags his tail.
            @vb dog=$PET ROVER:@pemit You pet Rover.; @emit Rover wags his tail.

[MOO]       @verb dog:pet this none none
            @program dog:pet
            player:tell("You pet Rover.");
            this.location:announce_all("Rover wags his tail.");

[MOOSE]     script dog:pet
                on pet me
                  tell player "You pet Rover."
                  emote wags his tail.
                end
```

The name "Rover" was written into the code of the above programs. Suppose you want the dog's name and gender to be automatically substituted in. This allows you to create a kind of "generic dog." Objects which inherit from generic dog can respond to their own name. (Inheritance is not used in MUSE; the program would have to be copied rather than inherited.) Code for a generic dog in each of these languages would be:

```
[MUSE] @va dog=$pet *:@switch %0=dog,{@pemit %#=You pet the dog.; spoof wags %p
            tail.},name(me),{@pemit %#=You pet [name(me)]; spoof wags %p
            tail.},@pemit %#=I don't see any %0 here!

[MOO]       @verb dog:pet this none none
            @program dog:pet
            player:tell("You pet ", this.name);
            this.location:announce_all($string_utils:pronoun_sub("%T wags %p tail.",
                this));

[MOOSE]     script dog:pet
                on pet me
                  tell player "You pet " + my name + "."
                  emote "wags " + my pp + " tail."
                end
```

In general, in MOO there are two syntaxes; MOOSE syntax is a combination of the two.

```
[MOO command line]      verb direct_object preposition indirect_object
[MOO code]              object:verb(argument1, argument2, ... argumentn);

[MOOSE]                 verb argument1 argument2 ... argumentn
```

The MOOSE language design is being revised as it is implemented and sample programs are tried out. It will be further revised based on feedback from an initial group of test users. A complete language specification and a narrative of how the language was designed and revised will appear in the written thesis. The thesis will evaluate the success of the MOOSE language

through interviews with children, and comparisons of their MOOSE programs to other children's creations in MUSE and MOO.

2.3 The MacMOOSE Client Program

It is possible to connect to a MUD using raw telnet, but this interface is awkward. The MacMOOSE client program adds the conveniences of a windowing system to make MOOSE more usable. MacMOOSE:

- Separates input from output, so that text generated by others does not interrupt what the user is typing.
- Puts help messages in a separate window, so that the information does not scroll away as the user tries out what it suggests.
- Allows WYSIWYG ("what you see is what you get") editing of text. If the user wants to correct "thhe" to "the" on the third line of a script or text document, he/she can simply click at the appropriate place in the window and then hit delete, rather than typing "substitute /thhe/the/3" in the line editor.
- Includes an object browser to display all the properties and scripts on an object, and climb the inheritance hierarchy to look at an object's parents or children.

Unfortunately, users not working on Macintosh computers will not be able to use MacMOOSE. It is still possible to access MOOSE Crossing without it. An alpha version of MacMOOSE was made available to fifteen test users in April 1994, and a fully-functional version is planned for December.

2.4 A Study of the Children's Experiences

A key contribution of this thesis, more important than the new technology developed, will be a thorough study of the impact of the project on its participants. The central question I plan to address is in what ways can community support and enhance constructionist learning? In order to address that top-level question, I will first investigate a number of specific, detailed questions about the children's experiences on MOOSE Crossing. (See section 1.6)

The study of the children's experiences on MOOSE Crossing has two major components. First, using an ethnographic methodology, I plan to work with a local group of children in an after school program. This will give me an opportunity to observe children using the system, and take careful notes. Some of the sessions will be either video or audio taped. I will interview the children before, during, and after the program. The interviews will be designed to assess the questions detailed in section 1.6.

Second, I plan to record all interactions in the virtual world. Written consent from both parents and children will be obtained for this recording.[7] This data can be used in a variety of ways. Statistical, computational analysis of the raw data collected is possible, but I believe only marginally interesting. More promising is the fact that I will be able to select a child, and analyze that child's complete experiences—every conversation, every command typed. I will analyze the complete experiences of a small group of children, including both children randomly selected and children selected because their backgrounds or experiences are in some way noteworthy.

3. IMPLEMENTATION

3.1 Resources

As an interpreted language written in an interpreted language, MOOSE is slow. The database is expected to be large, and the server keeps the entire database in memory. A fast workstation with generous amounts of RAM and swap space are needed. A Digital Equipment Corporation Alpha 3000/400 with 128 Mb of RAM has been dedicated to this project. One to two Gb of disk storage will be required for data collection.

A local school or community center with Macintosh computers connected to the Internet is needed for the after school program. The Somerville Community Computing Center has suitable facilities, and has expressed interest in participating in the project.

3.2 Progress to Date

The MediaMOO project served as preparation for the MOOSE Crossing project. MediaMOO is a MUD designed to be a professional community for media researchers. It has been open to the public since January 1993, and currently has 1100 members from 27 countries (Bruckman and Resnick 1993). Experience founding and managing MediaMOO has guided the design of MOOSE Crossing. In an informal ethnographic study of twelve adults who learned to program for the first time in a MUD (eight on MediaMOO; four on other MUDs), I gained insight into how an online community can motivate and support learning (Bruckman 1994).

The initial design and most of the implementation of the MOOSE language are complete. This design will be revised based on feedback from initial users. Major components still to be implemented include better error handling, better internal security, documentation, tutorials, and sample programs.

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[7]The details of this project will of course be cleared with MIT's Committee on the Use of Humans as Experimental Subjects (COUHES).

An alpha version of the MacMOOSE client program was released in April, and feedback from initial users has been positive. The design has been revised based on their comments. At present, we are almost ready to release a beta version.

3.3 Schedule

April 1994	Version 1.0a1 of MacMOOSE client program released
	First simple MOOSE program run
December 1994	Submission of thesis proposal
	Release of version 1.0b1 of MacMOOSE client program
January 1994	First alpha testers invited to MOOSE Crossing
	Release of version 1.0 of MacMOOSE client program
February 1995	MOOSE language revised based on alpha user feedback
March 1995	MOOSE Crossing opens to kids on the Internet
	After-school program begins
June 1995	Data analysis and writing begin
November 1995	Defense notification
	Submission of written thesis
December 1995	Oral defense

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MOOSE Crossing:
Creating a Learning Culture

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